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EDITORIAL

Protecting Public Lands and Public Health

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Our public lands are essential to the health and well-being of our communities. Ohio has 1.1 million acres of federal and state recreation lands, including Cuyahoga Valley National Park, Wayne National Forest, and our award-winning state parks.[1,2] Numerous county and city park systems also offer access to nature, educational activities, and programs for residents of all ages. Connecting many of these public lands is the Buckeye Trail. At nearly 1447 miles in length, it loops around the state and is on its way to being designated a National Scenic Trail. If advocates are successful, the Buckeye Trail will join 10 other trails, including the Appalachian Trail, the North Country Trail, and the Pacific Crest Trail, with the unique distinction of being the only loop trail among them. From well-known landmarks such as Old Man's Cave to the shores of Lake Erie to your neighbor's favorite spot for bird-watching, these public lands offer space for all Ohioans to relax, play, and connect.

Spending time in nature is good for our health. Exposure to nature is linked to improved mental health, sleep, blood pressure, and increased physical activity.[3] The number of Americans getting outdoors to recreate has been growing over the past decade, with outdoor participation rates in 2024 at 58.6%, their highest.[4] People enjoy the outdoors in many ways that include hiking, walking, Frisbee golfing, hunting, boating, skiing, fishing, rock climbing, geocaching, archery, photography, cycling, and, even, just good old-fashioned relaxing. There is truly something out there for everyone. Our public lands provide opportunities for people to get outside and engage in activities that improve their mental health, physical health, and quality of life.

Public lands also provide great opportunities for us, as public health professionals, to connect with our communities, develop programs, research their impact, and advocate for their protection. While the number of individuals recreating outdoors is growing, our public lands and parks are not fully accessible to all. Collecting data on access to public lands can help us better understand how existing spaces can be used and where we need to increase green space and access to the outdoors. We can work in partnership with local, state, and federal agencies, as well as nonprofits and private companies, toward developing programs that help people get outside. We can implement programs that encourage people to use our public lands, improve access to transportation to parks, create more green spaces in urban areas, and make parks more accessible for people with disabilities. As public health professionals, we can also continue to build research to understand how nature impacts health and how the use of public lands can impact surrounding communities.

There has long been a tension between using our public lands for recreation and conservation and industries that extract from them lumber, oil, gas, and minerals. This occurs regularly in both our state and federal governments. The outdoor recreation industry represents 2.3% of the national gross domestic product (GDP), well in excess of oil, gas, and mining combined.[5] In Ohio, it makes up 2.2% of our GDP.[5] Our public lands add value to our lives and economy, beyond resource extraction. As public health professionals and citizens, we must stay informed about policy changes as they come forward. Earlier this year, fracking began at Salt Fork State Park following a 2022 revision to Ohio law.[6] More recently, an executive order from the White House and a follow-up memo from the US Department of Agriculture opened Wayne National Forest to extensive logging. There are concerns that this federal policy change does not consider the local context of forest management and is unnecessarily aggressive in its plan to log national forest land across the United States. Overlogging in Wayne National Forest will negatively impact recreation, water quality, and wildlife and leave surrounding communities vulnerable to wildfires and flooding.[7] As public health experts, we can keep our elected officials informed about the health benefits of our public lands and help to develop policies that reflect good stewardship of our natural resources and a good quality of life for Ohioans. We can share our stories of experiences on public lands and what it means to us personally and for our communities. So, get out there, take a hike, jump in a lake, get some fresh air, or touch grass for your own health and for public health.

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RESEARCH ARTICLE

Public Perceptions of Air Quality in a County in Ohio

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ABSTRACT

Background: Decisions to protect health and well-being are influenced by public perceptions of air quality. To fill a gap in the literature, this descriptive study examined air quality perceptions in northwest Ohio and compared self-reports of air quality with the air quality index (AQI). Additionally, the perceptions of younger, middle-aged, and older participants were compared.

Methods: Survey questions were adapted from 2 previous research studies and distributed online to individuals who resided or worked in Lucas County, Ohio.

Results: The 181 participants were primarily White, female, college graduates with a mean age of 38 years. Most participants perceived the air quality in August 2020 to be unhealthy for sensitive groups or moderate whereas, based on the AQI, 45.2% of the days in August were categorized as good and 54.8% as moderate. Approximately 40% of participants stated that they or their family members had health problems exacerbated by poor air quality. Participants reported they were very likely or likely to stay inside if they knew the air quality was "bad" or "unhealthy." Although many participants checked the sky, smelled the air, or used a weather app to determine air quality, more older adults relied on television or radio reports while middle-aged adults looked online.

Conclusion: Local agencies may benefit from understanding air quality perceptions, and their relationship to AQI, to support air quality management practices. The public, and particularly vulnerable populations, should be informed about air quality tracking tools and how to alter their behaviors if necessary.

Keywords: Air pollution; Public opinion; Environmental health

INTRODUCTION

A statewide air quality advisory was issued by the Ohio Environmental Protection Agency (OEPA) for the first time on June 7, 2023, as smoke from Canadian wildfires adversely impacted air quality.[1] Then on June 28 and 29, the OEPA issued another statewide air quality advisory as smoke from Canadian wildfires continued. The air quality index (AQI) developed by the national Environmental Protection Agency (EPA) reports daily air quality from 0 to 500 based on values of 5 major pollutants: carbon monoxide, ground-level ozone, nitrogen dioxide, particulate matter (including PM2.5 and PM10), and sulfur dioxide, and is broken into 6 levels of health concern ranging from good to hazardous.[2] In June, the highest daily AQI in Toledo, Ohio, was 190 and was considered unhealthy.[3] The value of 100 generally corresponds to the pollutant's national air quality standard which is the level set by the EPA for protection of public health.[4]

In the United States (US) and world-wide, PM2.5 contributes to the largest proportion of adverse health effects related to air pollution.[5] Air contaminants can result in both acute (eg, coughing and wheezing, shortness of breath and chest discomfort) and chronic (eg, worsening cardiovascular and respiratory diseases, premature mortality) effects on health.[6,7] There are still acute and chronic health risks even when national air pollution regulations are met.[8,9] Additionally, vulnerable populations such as older adults or

those with preexisting diseases, such as asthma, may be more at risk.[6,10,11] For example, a relationship between short-term exposure to PM2.5 and an increased risk of hospitalization and death from heart and lung diseases, diabetes, and clots in the large veins of the legs was found in a sample of Medicare beneficiaries.[10] Recent studies have found a relationship between PM2.5 and the incidence of dementia.[12]

A few studies in the US have examined public perceptions of air quality, as well as the relationship between these perceptions and the AQI or PM2.5 concentrations.[13-16] Other studies have investigated the public's awareness of the AQI and where air quality alerts were seen or heard.[17,18] Individuals who lived in areas of high air pollution ranked it as the most serious problem compared to other community issues such as unemployment and crime.[15] Furthermore, awareness of air quality was higher in areas with AQI data available.[14] Air quality was perceived to be worse among females and those with preexisting health conditions.[13-15] Conversely, air quality was perceived to be better among Latinos and those who exercised regularly.[13] Blacks were more likely to be concerned about health effects related to air pollution.[16] Television was the most common medium for getting information or alerts.[13,16-18] Younger age groups, however, more often reported using an app on their mobile phone or device for receiving air quality alerts.[18] For sources of air quality information, older people were more likely to use an app or look online.[13] While behavior change resulting from air quality is not common, some individuals have reported using visual cues of air pollution to make changes in behavior, such as spending less time outdoors or closing windows.[14]

Background

Lucas County in northwest Ohio is bordered to the east by Lake Erie and southeast by the Maumee River. In 2020, the estimated population of Lucas County was 431 279 individuals.[19] The county contains the city of Toledo and its surrounding suburbs and is about 30% farmland and 10% forests.[20] In 2020, the private industry sectors with the highest percentage of workers were health care/social assistance (21.8%) and manufacturing (15.0%).[21]

Information from an environmental health assessment implemented by the Toledo-Lucas County Health Department revealed that air quality was an environmental concern for residents in the county.[22] Nine focus groups with 93 county residents were led by a trained moderator who facilitated discussion on health issues related to the environment. Residents thought air pollution was uncontrollable because of their exposure to different air pollution sources throughout the county. Many relied on their visual senses to indicate air quality and discussed personal preventive measures they use to combat poor air quality and protect their health. Residents expressed their views on air quality in the county and made decisions about changes in behavior based on their perceptions and health problems they experienced. Finally, residents discussed the various strategies (eg, stricter regulations) that could be and are being used to improve health and air quality in their communities. This information provided insights into residents' perceptions about air quality in the county and helped guide the design of the quantitative survey for the current study.

As impacts from climate change, including smoke from wildfires, affect air pollution and more Americans experience poor air quality, it is important to understand individuals' perceptions. Perceptions of environmental concerns, including air quality, influence decisions to protect health and well-being. This descriptive study is the first to examine perceptions of individuals in Lucas County, Ohio, related to air quality, sources of air pollution, factors affecting air quality, credible sources of air quality information, and behavior change based on air quality. Individuals' reports of air quality were also compared to the AQI during the same period. This knowledge may assist local agencies or communities with air quality management such as source control or targeted campaigns to increase awareness of the health impacts related to air quality, particularly for vulnerable populations.

METHODS

Design

A cross-sectional survey was conducted in September 2020 in Lucas County, Ohio, to assess public perceptions and concerns about air quality in the prior month. Perceived levels of concern were compared with levels of concern associated with the AQI during August 2020.

Participants

Convenience sampling was used for the study. Eligible participants were those who stated they resided or worked in the county, were at least 18 years of age at the time of the study, and could read and write in English.

Data Sources

Air Quality Perceptions Survey. A survey was adapted from the research studies conducted by Brown et al[13] and Reames and Bravo[16] and disseminated in September 2020. Some questions used from these studies were revised to improve understandability, readability, and applicability to the Lucas County area. Since ozone is highest in the summer and people spend more time outdoors, the air quality in the county during the prior month of August was rated. Survey questions also included ranking the seriousness of community issues as well as reporting perceived sources of air pollution, the factors affecting "bad" or "unhealthy" air quality, the factors used to determine "good" air quality, what are the credible air quality information sources in the county, and the likelihood of modifying behaviors due to the air quality. The Appendix contains the primary questions in the survey related to air quality and does not include the demographic questions.

Air Quality Data. This study used publicly available AQI data for Lucas County, Ohio, during 2020 (https://aqs.epa.gov/aqsweb/airdata/download_files.html). The AQI provides information about

local air quality, potentially affected groups of people, and steps to reduce air pollution exposure.[2] The AQI is required to be reported to the public 7 days a week for metropolitan statistical areas (MSAs) with a population greater than 350 000, such as Toledo. The AQI is calculated from measured pollution concentration data for 5 major pollutants (ozone, particulate matter, carbon monoxide, nitrogen dioxide, sulfur dioxide), each with a national ambient air quality standard (NAAQS) established by the EPA to protect public health (TAD). If multiple pollutants are measured, an AQI is calculated for each, and the pollutant with the highest value is the reported AQI for the day.[2] For Lucas County, the AQI was the maximum value of 2 pollutants, the daily mean PM2.5 concentration or ozone, monitored at 5 outdoor sites maintained by the City of Toledo Environmental Services.[3] Six established AQI color-code categories correspond to different levels of health concern and include good (0-50), moderate (51-100), unhealthy for sensitive groups (101-150), unhealthy (151-200), very unhealthy (201-300), and hazardous (>300).[2]

Procedures

Following University of Toledo institutional review board approval (#300479-UT), a cover letter and survey were made available via Qualtrics, an online survey platform. The cover letter was provided to explain the details of the study, and subsequent consent was implied by proceeding to the survey. Participants were primarily recruited via postings with the Qualtrics link on various social media group sites. An email message was also sent by a marketing and communications specialist with access to email addresses at a state university that invited faculty, staff, and students to complete the survey by clicking the link. Additionally, postcards with the Qualtrics link were distributed at libraries and outdoor venues such as malls and parks. Participants were not compensated for their participation in this study.

Survey data were downloaded from Qualtrics and analyzed in SPSS using descriptive and inferential statistics. Based on previous studies that found age differences, age groups were also compared on air quality information and changes in behavior. Descriptive statistics (ie, median, range) were calculated on the AQI data for August 2020 and the entire year, and the percentage of days in each level of concern were determined.

RESULTS

Demographics

The demographic profile for the participants (n=181) is presented in Table 1. The majority of participants were White (92.3%), female (74.6%), and non-Hispanic or non-Latino (94.5%). Participants' ages ranged from 18 to 86 years, with a mean of 38 years. There were 80 (51.9%) younger, 37 (24.0%) middle-aged, and 37 (24.0%) older individuals.

Air Quality Data

In 2020, 70.6% (250/354) of days in Lucas County were considered good based on the AQI, 27.1% (96/354) were moderate, and 2.3% (8/354) were unhealthy for sensitive groups.[3] Over 2020, the maximum AQI was 136 and the median was 42. More specifically, in August 2020, the median AQI was 52 (range of 27-84), with 14 good days (45.2%) and 17 days (54.8%) that were moderate.[3]

Perceptions of Air Quality

Participants rated the air quality in the past month (ie, August) as good (13.3%), moderate (39.9%), unhealthy for sensitive groups

Table 1. Participants' Demographic Profile

Demographic Variable		n	Percent (%)
Gender		181	
	Male	44	24.3
	Female	135	74.6
	Another	2	1.1
Self-reported race		181	
	White	167	92.3
	Black/ African American	7	3.9
	Asian	2	1.1
	Other	4	2.2
Ethnicity		165	
	Non-Hispanic or Non-Latino(a)	156	94.5
	Hispanic or Latino(a)	7	4.2
	Prefer not to answer	2	1.2
Annual household income		180	
	Less than $24 999	31	17.2
	$25 000 to $49 999	37	20.6
	$50 000 to $99 999	40	22.3
	$100 000 to $149 999	37	20.3
	$150 000 or more	23	12.8
	Prefer not to answer	12	6.7
Highest level of education		181	
	High school	14	7.7
	Some college	35	19.3
	College	74	40.9
	Graduate school	58	32.0

(41.0%), or unhealthy (5.8%). None of the participants thought the air quality in the previous month was very unhealthy or hazardous.

Most of the participants (44.2%) believed air pollution was a somewhat serious problem, while only 3.9% thought that air pollution was a very serious problem in Lucas County. The most frequently reported very serious problems were the opioid crisis (45.9%), crime (33.1%) and obesity (32.6%) (Table 2).

The majority of participants rated their general health as very good (40.6%) or good (32.9%). Almost 40%, however, reported they had health problems that were made worse by poor air quality, and 40% had family members with health problems that were made worse. Asthma and allergies were the most common health problems exacerbated by poor air quality. A significant relationship was found between participants' perception of air quality and whether they reported any health problems made worse by the air quality (p=0.009).

Air Quality Impact on Individual Behaviors

Participants reported they were very likely or likely to change their individual behaviors if they knew the air quality was "bad" or "unhealthy" by staying inside with the windows and doors closed (58.4%) and limiting their outdoor activities such as work (52.0%), exercise/sports (49.7%), and hobbies (47.4%). Significant relationships were also found between those participants who stated their health problems were affected by poor air quality and whether they limited their hobbies outside (p=0.041) or work outside (p=0.049).

Perceptions of Air Pollution Sources

Half of the participants indicated the air quality was "bad" or "unhealthy" if it had a bad smell. The sources participants perceived as contributing somewhat or a lot to air pollution were manufacturing (90.3%), cars and trucks (86.2%), oil refineries (82.2%), construction (68.0%), landfills (63.4%), farms and agriculture (56.3%), and open burning (46.9%).

Air Quality Information

Factors participants used to determine air quality are reported by young, middle, and older age groups in Figure 1. A high percentage of participants in all age groups reported that they decided whether the air quality was good by going outside and looking at the sky or smelling the air and using a weather app. A larger percentage of older adults checked reports on the TV or radio (78.4%) but less used social media (27.8%) compared to the younger and middle age groups. The middle age group more often reported looking online (78.4%), compared to the younger and older age groups.

Across the 3 age groups, participants believed the most credible sources of air quality information were the EPA, university researchers, and the news media (see Figure 2). The City of Toledo and the Toledo Metropolitan Area Council of Government were perceived as more credible by the younger age group (76.9%; 78.2% respectively) compared to the middle (59.5%; 65.7% respectively) and older age groups (45.7%; 54.3% respectively). Personal social media was considered the least credible source by all age groups.

Changes in Behavior to Reduce Air Pollution

Figure 3 shows the individual behaviors that participants performed to reduce air pollution. The top behavior reported by the younger adults was using a bicycle or walking (69.7%). Middle-aged and older adults did not overfill or 'top off' their gas tank (82.4% and 75.8%, respectively). Additionally, middle-aged adults made fewer driving trips to reduce air pollution (82.4%).

DISCUSSION

Since 1990, concentrations of air pollutants have dropped dramatically across the US, largely due to policies like the Clean Air Act. Specifically, ozone (8-hour) has decreased 22% and PM2.5 (24-hour and annual) has decreased 42%.[23] Although individuals in Lucas County, Ohio, identified that air pollution was not the most serious problem in the area, only 13% stated that the air quality was good. The actual AQI indicated the air was categorized as good for almost half of the days in August of 2020. Like much of the nation, the air quality in Lucas County, Ohio, is typically below concern. Individual decisions to protect health and well-being are influenced by perceptions of air quality, however, which may or may not correspond to AQI values. In the current study, most individuals in Lucas County, Ohio, reported the air quality was unhealthy for sensitive groups or moderate. Only 6% of residents stated that the air quality was unhealthy. Whereas, 20% and 22%

Table 2. Participant Perceptions about the Problems in Lucas County, Ohio

Problems	N	Not at all serious n (%)	A little serious n (%)	Somewhat serious n (%)	Serious n (%)	Very serious n (%)
Car accidents	180	7 (3.9)	46 (25.6)	**74 (41.1)**	47 (26.1)	6 (3.3)
Unemployment	180	5 (2.8)	23 (12.8)	58 (32.2)	**72 (40.0)**	22 (12.2)
Crime	181	1 (0.6)	10 (5.5)	40 (22.1)	**70 (38.7)**	60 (33.1)
Air pollution	181	9 (5.0)	44 (24.3)	**80 (44.2)**	41 (22.7)	7 (3.9)
Infectious diseases (eg, COVID, HIV)	180	6 (3.3)	26 (14.4)	53 (29.4)	**63 (35.0)**	32 (17.7)
Opioid crisis	181	1 (0.6)	8 (4.4)	22 (12.2)	67 (37.0)	**83 (45.9)**
Obesity	181	2 (1.1)	5 (2.8)	42 (23.2)	**73 (40.3)**	59 (32.6)
Water Quality	181	8 (4.4)	26 (14.4)	49 (27.1)	**62 (34.3)**	36 (19.9)

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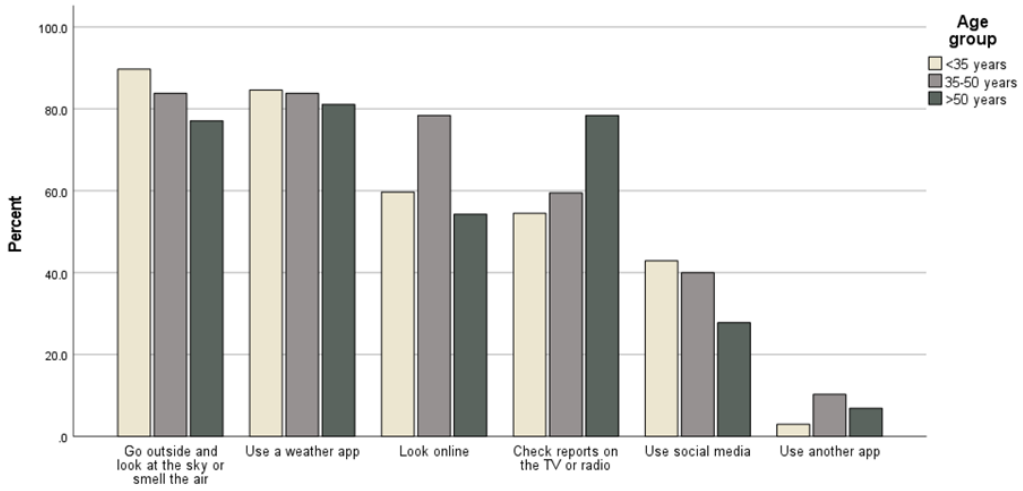

Figure 1. Factors Participants Used to Determine Air Quality

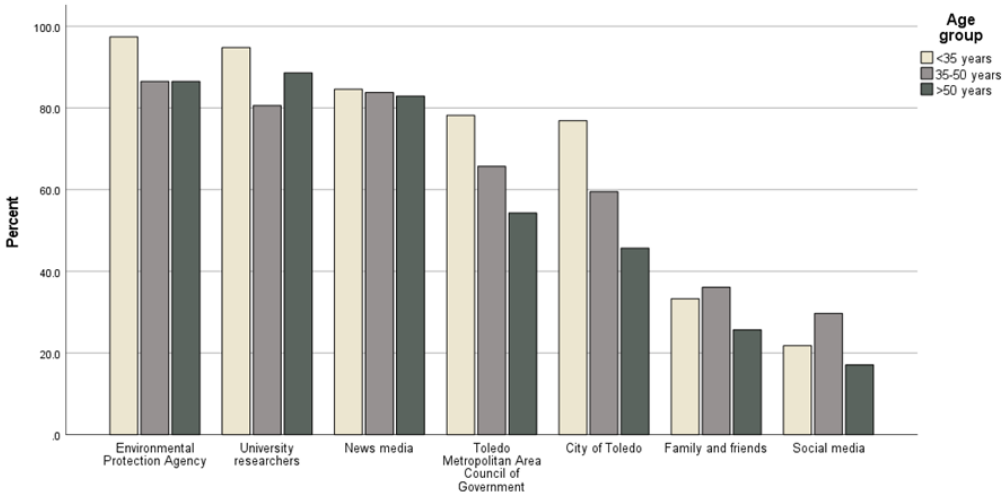

Figure 2. Credible Sources of Air Quality Information

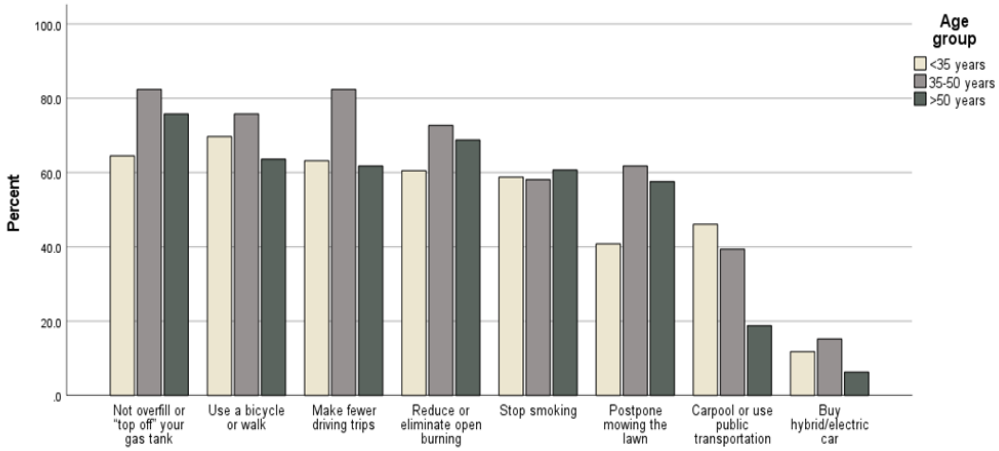

Figure 3. Individual Behaviors to Reduce Air Pollution

of San Joaquin Valley residents in California reported their air quality was unhealthy.[13,15] One study reported that the majority of their participants (75%) in the San Joaquin Valley were exposed to moderate air quality or medium concentrations of PM2.5 (ranged between 12 and 25 μg/m3).[15] Individuals thought that air pollution was a 'somewhat serious' problem in Lucas County, but the opioid crisis, crime, and obesity were the most frequently stated 'very serious' problems. Cisneros et al also found that air pollution ranked behind unemployment, crime, and obesity but that those who live in areas of high air pollution ranked it as the most serious problem.[15]

The individuals in the current study, of which the majority were female, reported that the air quality was poorer than the AQI. Cisneros et al[15] found that air quality was perceived to be worse among females and Brown et al[13] stated females were also more likely to check the AQI. Additionally, those with preexisting health conditions perceived the air quality to be poorer.[13,14] Individuals in Lucas County who had health problems, or reported they had family members with health problems, thought that the air quality made those problems worse.

The main sources of air pollution identified by individuals in the current study were manufacturing, vehicles, and oil refineries. Cisneros et al found that vehicles, windblown dust, and factories were perceived as the main contributors.[15] Visual cues and odor were the primary factors that individuals in Lucas County used to determine the quality of the local air. Weather apps were also frequently used. Similarly, Brown et al found that residents gathered information about air pollution from looking at the sky, checking television reports, seeing the mountains clearly, or smelling the air.[13] Since PM2.5 cannot be seen with the naked eye, it may be one of the reasons there is a difference between air quality perceptions and the AQI.

Air quality alerts on television reach the largest percentage of US adults, although the proportion reporting this channel is decreasing.[16-18] Older adults in the current study checked air quality reports on the television or radio but were less likely to use social media compared to the younger and middle age groups. Tompkins et al found that younger age groups did not report receiving alerts via television but more often report using an app on their mobile phone or device.[18] With regard to sources of air quality information, Brown et al found that older people were less likely to rely on whether they could see the mountains or check the TV or an air quality index.[13] Individuals across the 3 age groups in the current study thought the most credible sources of air quality information were the EPA, university researchers, and the news media.

While behavior change resulting from air quality is not common, some studies have reported that individuals use visual cues of air pollution to make changes in behavior.[14] On days individuals in Lucas County thought the air quality was "bad," they played outside less, did less hobbies or work outside, and stayed indoors with the windows and doors closed. Mirabelli et al found that people spent less time and did less strenuous activities outside, drove less, and closed their windows if there were more days with alerts of unhealthy air.[14] Brown et al found that females, Latinos, and people of other ethnicities reported avoiding exercising if the air quality was poor.[13] Some older and middle-aged individuals in Lucas County stated that they did not "top off" the gas tank in their car, while younger individuals used a bicycle or walked.

Despite the knowledge gained from this study, there are limitations. The pandemic restricted the ability to disseminate postcards and paper surveys, so recruitment of participants relied mainly on social media. Social media enables researchers, however, to provide general information about a study to a wider range of individuals who might otherwise be inaccessible to the researchers.[24] Additionally, using an online survey may have reduced the number of participants with a lower income or education level and may limit the generalizability of the results. Overall, the air quality of many urban areas improved during the lockdown period of the pandemic, however, the individuals in this study still rated the air quality as worse than the AQI during this time.[25-27] Whether perceptions are accurate or not, they may change individuals' behaviors.

PUBLIC HEALTH IMPLICATIONS

Despite air quality that has been steadily improving over the past several decades, recent wildfire smoke has influenced air quality in nearly 75% of states in the US.[28] Although impacted by wildfire smoke, the air quality on 73% of the days in June of 2023 in Lucas County, Ohio, was still categorized as good or moderate. If the AQI is unhealthy, however, individuals should reduce their short-term exposure, especially those at greater risk. Long-term behavior changes that individuals can make to reduce air pollution include walking, biking, and taking public transit to reduce vehicle emissions, switching to green power from renewable energy sources, and planting trees to improve air quality. This study's findings may direct air quality management, such as source control or public health campaigns to increase awareness of community health impacts. Health and government officials can also ensure the public understands the true impacts of poor air quality days in their community and develop appropriate alerts for individuals potentially affected. Future research could examine current perceptions of air quality in Lucas County and whether perceptions in the Midwest have changed as wildfires become more prominent.

Air quality has improved dramatically, but the increasing number of air alert days due to wildfires in the past few years has heightened awareness of air pollution and affected individuals' behaviors. These descriptive results begin to elucidate the air quality perceptions of individuals who live in Ohio and can be used to guide a larger study. Understanding public perceptions can also assist local and regional health officials in increasing individuals' comprehension of good and bad air quality days, and subsequently alert individuals if necessary. The findings reveal important opportunities to inform the public about potential health effects of air

pollution, particularly for vulnerable populations, but also to increase awareness of tools (eg, weather apps, AQI website) that the public can use to know the air quality and respond appropriately. The Internet and apps on mobile phones or devices have greatly increased the ability to immediately provide and receive information. Education should be provided to the public on how to use the AQI to guide their outdoor activities and reduce their short-term exposure when the AQI is unhealthy.

CONFLICTS OF INTEREST

The authors declare they have no conflicts of interest.

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AUTHOR CONTRIBUTION

Substantial contributions to the conception or design of the work: Ashleigh Konopka, April Ames, Victoria Steiner, Michael Valigosky. Acquisition, analysis, and interpretation of data for the work, drafting the work or revising it critically for important intellectual content, final approval of the version to be published, agreement to be accountable for all aspects of the work: all authors.

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APPENDIX—Air Quality Survey Questions

1. How serious of a problem is each of the following in Lucas County?

	Not at all serious	A little serious	Somewhat serious	Serious	Very serious
Car accidents					
Unemployment					
Crime					
Air pollution					
Infectious diseases (eg, COVID, HIV)					
Opioid crisis					
Obesity					
Algal blooms					

2. How do you decide whether the air quality is good? Do you … (For each item below, please place an 'X' in the column that relates to your answer).

	Yes	No
Go outside and look at the sky or smell the air		
Check reports on the TV or radio		
Look online		
Use social media (eg, Facebook, Twitter)		
Use a weather app		
Use another app, please specify:		
Other, please specify:		

3. What sources below do you find credible for air quality information?

	Yes	No	Don't know
News media (eg, television, radio, newspaper)			
Family and friends			
Social media (eg, Facebook, Twitter)			
Environmental Protection Agency (EPA)			
Toledo Metropolitan Area Council of Government (TMACOG)			
City of Toledo			
University researchers			
Other, please specify:			

4. Which <u>one</u> of these sources above do you consider to be most credible?

5. In the past month, what has the air quality been like in Lucas County?
   Good air quality
   Moderately healthy
   Unhealthy for sensitive groups
   Unhealthy
   Very unhealthy
   Hazardous

6. How much do each of the following contribute to air pollution in Lucas County?

	Not at all	A little bit	Somewhat	A lot	Don't know
Cars and trucks					
Farms and agriculture					
Landfills					
Manufacturing					
Oil refineries					
Construction					
Open burning					
Other, please specify:					

7. If you know that the air quality is bad or unhealthy, how likely is it that you would …
   (For each item below, please place an 'X' in the column that relates to your answer).

	Very unlikely	Unlikely	I'm not sure	Likely	Very likely
Exercise or play sports less outside					
Do less hobbies outside (eg, gardening)					
Work outside less					
Stay inside with windows and doors closed					
Other, please specify:					

8. Would you say that in general your health is
   Excellent
   Very good
   Good
   Fair
   Poor

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9. Do you have any health problems that are made worse by the air quality?
   Yes, what are they?
   No

10. Do any family members who are living with you have any health problems that are made worse by the air quality?
   Yes, which family member(s) and what health problem(s) do they have?
   No

11. What activities do you or have you done to reduce air pollution?

	Yes	No
Carpool or use public transportation		
Use a bicycle or walk		
Not overfill or "top off" your gas tank		
Make fewer driving trips		
Postpone mowing the lawn		
Buy hybrid/electric car		
Reduce or eliminate open burning		
Stop smoking (eg, cigarettes, marijuana, etc.)		
Other, please specify:		

12. Is there anything you would like to add? If so, please write it in the space below.

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RESEARCH ARTICLE

Assessing Temporal Changes in Spatially-Varying Disparities in Tobacco Retailer Density across Ohio

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ABSTRACT

Background: Place-based disparities in tobacco retailer density (TRD) are related to place-based disparities in tobacco use. This project aimed to assess the equity of changes in TRD disparities for various communities over the last 5 years. In addition, we sought to explore how changes varied as a function of local tobacco retailer licensing policies.

Methods: In 2017 and 2022, we geocoded all tobacco retailers (including hookah cafés and vape shops) in Ohio and used census-derived information to categorize 3149 census tracts based on their demographic characteristics. With these data, we calculated cross-sectional TRD disparities, then estimated changes in TRD from 2017-2022. We also assessed tracts that had (vs had not) implemented tobacco retailer licensing. Analyses used negative binomial models adapted to account for spatial association across tracts and temporal dependence over years.

Results: There was hardly any change in overall TRD over the 5-year period (1.77% decline). However, disparities were slightly attenuated for tracts with a high prevalence of Hispanic individuals, children, poverty, and African American individuals. The TRD did not decline for rural (vs suburban) areas; furthermore, rurality was one of the strongest predictors of TRD. In suburban and urban areas (where tobacco retailer licensing was most common), TRD declined more in high-poverty tracts that did (vs did not) have tobacco retailer licensing.

Conclusion: Declines in TRD were greater for some communities than others. In particular, there was no indication that TRD is declining in rural areas of the state. Findings indicate the need for support and expansion of state and local-level tobacco control policies.

Keywords: Tobacco retailer density; Tobacco control; Disparities; Equity; Policy; Tobacco retailer licensing

INTRODUCTION

The term "tobacco retailers" refers to all types of stores that sell tobacco products; these can include gas stations, convenience stores, grocery stores, dollar stores, pharmacies, tobacco shops, vape shops, etc. Unfortunately, the locations of tobacco retailers are not uniformly distributed. Rather, there are disparities in tobacco retailer density (TRD), meaning that tobacco retailers are disproportionately located in systematically divested neighborhoods including low-income neighborhoods, neighborhoods with a high prevalence of racial or ethnic minority individuals, and rural areas.[1–6] And these disparities in tobacco retailer density (TRD) are related to disparities in tobacco use.[7] Such an association is to be expected: tobacco retailers are not only a major point of access to tobacco products but also a primary source of exposure to tobacco marketing.[8] Consequently, living in neighborhoods with a high TRD has been associated with greater tobacco use and worse cessation outcomes.[7,9–12] There have even been linear relationships found between degrees of disparity in TRD and degrees of disparity in tobacco use.[13]

Although a robust literature of cross-sectional data has documented these TRD disparities, it is important to recognize that the location of tobacco retailers is not static over time. Rather, the

locations of tobacco retailers are dynamic and impacted by numerous factors. For example, there was greater volatility in retailer closings and openings following the Great Recession of 2007-2009,[14] and economic hardships associated with the COVID-19 pandemic impacted many retailer closures and turnover.[15–17] Additionally, local-level tobacco control efforts targeting the retail environment are being adopted by many communities.[18] Chief among these is tobacco retailer licensing, where a retailer is required to purchase a license to sell tobacco.[19] The cost of the license, which typically must be renewed annually, can be a disincentive for selling tobacco.[20] The tobacco retailer licensing also provides funds and infrastructure for local retail enforcement including compliance checks and penalizing or suspending retailers for repeated sales violations (eg, sales to underage youth).[21] Thus, the number and distribution of tobacco retailers can change substantially over time.[14]

But what has been the impact of these changes in tobacco retailers for TRD disparities? There are many gaps in our understanding of this topic. Unfortunately, some data indicate disparities in tobacco use are rising.[22] One of the only studies assessing changes in TRD found that, from 2000-2017, poverty-based disparities in TRD reduced while racial and ethnic-based disparities remained unchanged.[23] Whether these trends have continued in recent years remains unknown. Also unknown are how trends change over time for rural (vs urban) areas, and across the intersection of community characteristics (eg, low-income racial minority neighborhoods vs high-income racial minority neighborhoods). Finally, little is known about how tobacco retailer licensing impacts changes in TRD disparities.

This project's objective was to assess recent longitudinal changes in TRD disparities that have historically been observed cross-sectionally at the neighborhood level: disparities based on neighborhood income, racial and ethnic composition, and rurality. In exploratory analyses, we also examined how these changes varied as a function of tobacco retailer licensing. Analyses were conducted for the state of Ohio, as this is a large state (over 44 000 square miles and a population of over 11.7 million) with a varied sociodemographic profile and good representation of our groups of interest. Further, Ohio was unique in having no tobacco retailer licensing at baseline (2017) but several jurisdictions implementing tobacco retailer licensing over the course of a 5-year period.

METHODS

Measures

Tobacco Retailers. In 2017, and again in 2022, the names and addresses of all retailers with active state cigarette licenses (gas stations, grocery stores, tobacco shops, etc) were obtained from Ohio's county auditor offices. To collect information on hookah cafés and vape shops that did not have a state cigarette license, we employed methods described by Kates et al[24] for searching internet directories. Our final list contained 11 458 tobacco retailers in 2017 and 11 341 in 2022 (including hookah cafés and vape shops, which together comprised 3% of retailers in 2017 and 4% in 2022). We geocoded the longitude-latitude coordinates corresponding to the retailer addresses using the tidygeocoder[25] R package.

Sociodemographic Characteristics. For all Ohio census tracts ("tracts"), we obtained information about race/ethnicity, poverty, age, and population size from the 2016 and 2022 American Community Survey (ACS) 5-year estimates. The 2016 ACS values were used as covariates in modeling the tobacco retailer counts in 2017; the 2022 ACS values were used as covariates in modeling the retailer counts in 2022. For this paper, we were particularly interested in identifying trends for historically divested census tracts, characterized by poverty, race/ethnicity, and rurality. Cutoffs distinguishing "high" and "low" groups were selected a priori and justified elsewhere.[26] Tracts were coded for high (vs low) prevalence of African Americans [or Hispanics] if ≥15% of the population was African American [or Hispanic]. Tracts were coded for high (vs low) prevalence of young people if ≥25% of the population was under age 18. Finally, tracts were coded for high (vs low) prevalence of poverty if >15.4% of the population was below the poverty level (15.4% was the state poverty level in the 2016 ACS). To aid in the comparison over the 2 time periods, we also used 15.4% to define a high (vs low) prevalence of poverty in 2022. To determine whether a tract was urban, rural, or suburban, we used the National Center for Health Statistics' 2013 Urban-Rural Classification Scheme for Counties.[27] A level 1 county was coded as "urban," levels 2 and 3 were coded as "suburban," and levels 4, 5, and 6 were coded as "rural."

The TIGER shapefiles defining tracts in Ohio came from the US Census Bureau.[28] Our procedure for configuring sociodemographic variables across 2 timepoints on a single set of 2021 census tracts is described in the Appendix. Following our established methodology to guard against low retailer counts,[26] we restricted our analyses to tracts with a minimum population of 500 people (17 tracts had populations of <500 people, 15 had no population). Two more tracts were removed for having missing poverty values. Our final analysis had data for 3149 tracts.

Tobacco Retailer Licensing. Although Ohio already has a state-level retailer license for cigarettes, more comprehensive local tobacco retailer licensing had begun appearing in the state. In addition to including all types of tobacco products beyond cigarettes (eg, e-cigarettes, cigars, hookah), the local tobacco retailer licensing required annual license fees and provided stronger infrastructure for enforcement, such as unannounced compliance checks for underage sales, with penalties for violations (including fines and suspended or revoked licenses). We compiled a list of all localities in Ohio that enacted a tobacco retailer licensing policy before 2022; none of these tobacco retailer licensing policies were enacted before 2017 (our baseline period). This list comprised 13 Ohio cities, including those within the highest population counties: Cuyahoga, Franklin, and Hamilton (Table 1). We obtained

Table 1. Ohio Cities That Passed Local Tobacco Retailer Licensing Policy between 2017 and 2022

City	County	Tobacco retailer density (TRD) in 2017 (per 1000 people)[a]	Population in 2017 (thousands)[b]
Brook Park	Cuyahoga	0.85	18.8
Brooklyn	Cuyahoga	1.27	11.0
Cleveland Heights	Cuyahoga	0.71	45.0
Euclid	Cuyahoga	0.90	47.9
Lakewood	Cuyahoga	1.11	46.8
Maple Heights	Cuyahoga	1.54	22.7
Moreland Hills	Cuyahoga	0.25	4.0
Newburgh Heights	Cuyahoga	1.26	7.1
University Heights	Cuyahoga	0.30	13.3
Columbus	Franklin	0.93	887.7
Dublin	Franklin	0.45	44.7
Cincinnati	Hamilton	1.16	304.7
Norwood	Hamilton	1.38	19.6

[a]Tobacco Retailer Density (TRD) is calculated over all census tracts containing the city.
[b]Population was calculated as the aggregate population over all census tracts containing the city.
Notes: Includes county, tobacco retailer density (TRD), and population. Corresponds to 430 census tracts (13.7% of all tracts in state). The TRD over all other Ohio census tracts (ie, those not included in the table) is 0.99 per thousand people in 2017.

shapefiles of the cities of Columbus and Cincinnati from the Centers for Disease Control and Prevention.[29] For smaller cities, we manually traced city boundaries using Google Maps and calculated which 2021 tracts were contained within, or had at least a 50% overlap with, each of these cities.

Statistical Analyses

Analyses were carried out using R.[30] Analyses began with descriptive statistics to map and characterize tracts and TRD at both timepoints. The TRD was calculated as the number of retailers per 1000 people in a tract. Using our common set of tracts, we determined the median TRD and percentage change in median TRD across high vs low levels of our sociodemographic characteristics.

Any instance where median TRD was greater for divested, compared to nondivested, neighborhoods (eg, tracts with high vs low prevalence of poverty) was considered a TRD disparity. And any instances where the percent change in median TRD was greater for divested, compared to nondivested, neighborhoods was considered an equitable decline in TRD.

Next, we fit a statistical model to understand the relationship between TRD and sociodemographic variables in 2016 and 2022, while accounting for possible spatiotemporal dependencies. We used a marginal modeling approach, which specifies a model for the mean, variance, and correlation. The model for the log mean TRD accounts for the effect of sociodemographic variables that could be different over years, as well as the urban/suburban/rural status of the tract. The variance of a negative binomial model allows for overdispersion in the response[26] (ie, extra variance relative to what we could observe in a Poisson model). For the correlation model, we assumed a conditional autoregressive (CAR) model over tracts and an autoregressive (AR) model over time. The Appendix provides further details on the statistical model and fitting methodology.

Finally, to explore the impact of local tobacco retailer licensing on TRD in 2022, we added an indicator variable to our statistical model that indicated whether tobacco retailer licensing was enacted within that tract (yes or no). We then compared TRD change predicted from the model for different combinations of sociodemographic variables. For this exploration, we fixed the age group to be a low prevalence of children. Recognizing similar patterns across high-prevalence African American tracts and high-prevalence Hispanic tracts, we compared low-African American/low-Hispanic tracts to high-African American/high-Hispanic tracts.

RESULTS

Tobacco Retailer Density (TRD) 2017 and 2022

For the state of Ohio, there was a 1.77% statewide reduction in TRD between 2017 and 2022. However, there was substantial variation across tracts in both the direction and magnitude of TRD change over this 5-year period (Figure 1). We found 22.1% of tracts experienced an increase in TRD from 2017-2022; among these, the mean increase was 0.50 retailers per thousand people. Another 24.5% of tracts experienced a decrease in TRD from 2017-2022; among these, the mean decrease was 0.66 retailers per thousand people. Thus, across tracts, the decrease slightly outweighed the increase.

Tobacco Retailer Density (TRD) Disparities—Descriptive Statistics for Cross-Sectional and 2017-2022 Changes

The distribution of ACS-based sociodemographic characteristics changed somewhat in Ohio over our period of observation (Table 2). As compared to 2017, the prevalence of tracts in 2022 classified as "high prevalence African American," "high prevalence under 18," and "high poverty" decreased, and the prevalence of tracts classified as "high prevalence Hispanic" increased. Median TRD decreased from 2017-2022 for tracts classified as both high- and low-prevalence African American, with a greater decrease in high-prevalence tracts (a 2.5% decrease vs 1.3% decrease, respectively; Table 2). Median TRD decreased by 14.7% for tracts classified as high-prevalence Hispanic and 2.5% for tracts classified as

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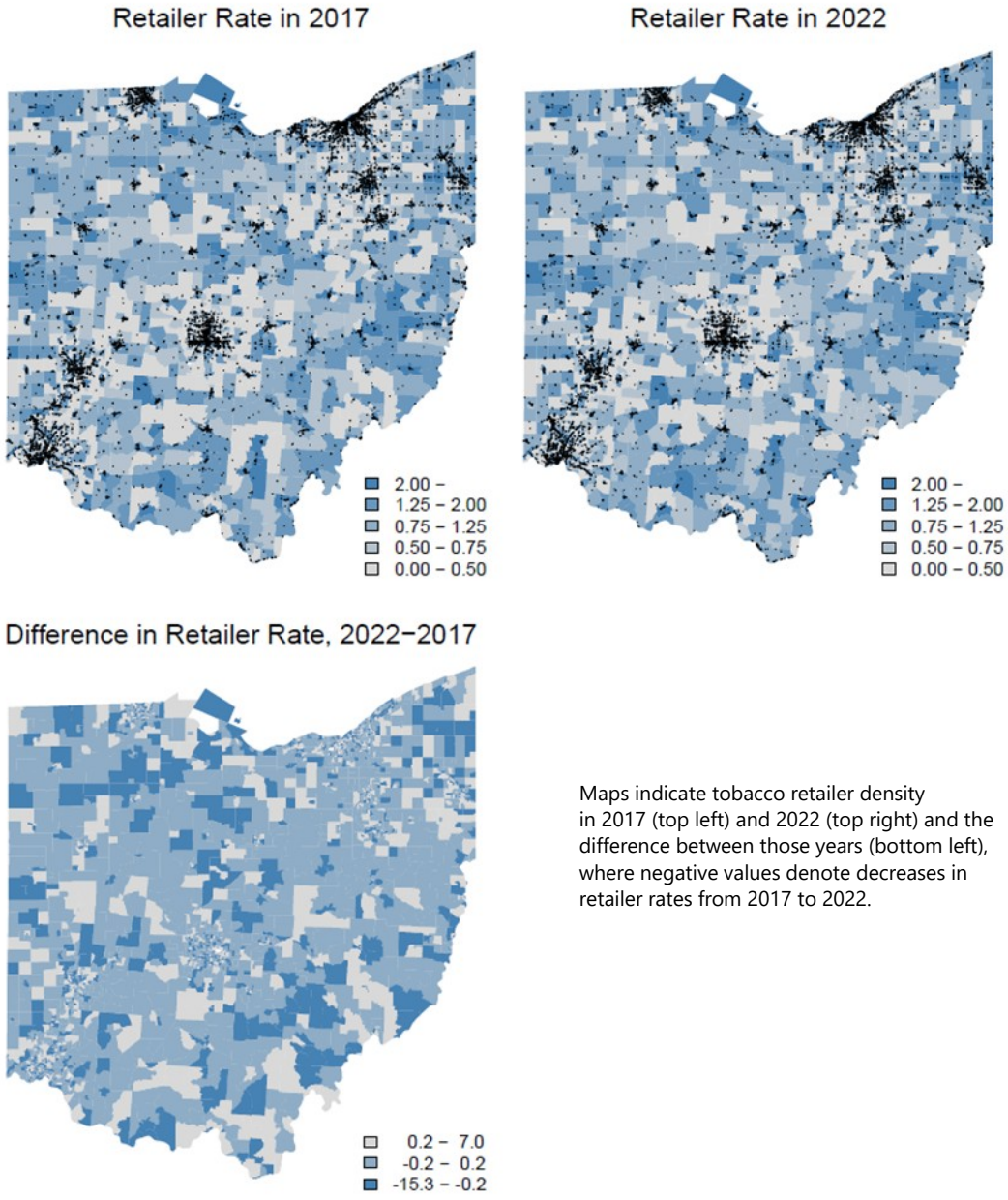
low-prevalence. For tracts with a higher prevalence of people aged under 18 years, the decrease of 6.6% was higher than the decrease for tracts with a lower prevalence (2.2%). In terms of poverty, TRD decreased 2.2% for high-poverty tracts, but increased by 2.1% for low-poverty tracts. Finally, we observed a decrease for urban tracts and suburban tracts (0.8% and 3.2%, respectively) but a slight increase in TRD of 0.3% for rural tracts.

Multivariable Models of TRD Disparities–2017 and 2022

After applying Wald tests to simplify the model, the only interaction term we retained in our model was the interaction between the prevalence of children (ie, people under age 18) and poverty (Table 3). The final model (Table 3, Model 1) indicated that, at both timepoints, there was significantly greater TRD in tracts with a high (vs low) prevalence of African Americans (exp (0.138)=1.15 times as many retailers in 2017; exp(0.101)=1.11 times as many in 2022). There was also significantly greater TRD in tracts with a high (vs low) prevalence of Hispanic individuals (1.25 times in 2017; 1.19 times in 2022). There was no significant difference in TRD between suburban and urban tracts in 2017; however, by 2022, there was significantly greater TRD in suburban vs urban tracts (1.09 times as many). At both timepoints, there was significantly greater TRD in rural vs urban tracts (1.30 times as many in 2017 and 1.36 times in 2022).



Maps indicate tobacco retailer density in 2017 (top left) and 2022 (top right) and the difference between those years (bottom left), where negative values denote decreases in retailer rates from 2017 to 2022.

Figure notes: Black points indicate retailer locations.
Top row: Darker colors indicate greater tobacco retailer density, measured as number of retailers per 1000 people.
Bottom row: Darker colors indicate greater increase in tobacco retailer density over the 5-year period.

Figure 1. Ohio Tobacco Retailer Density Maps at Census Tract Level

Table 2. Sociodemographic Characteristics and Tobacco Retailer Density (TRD) in 2017 and 2022, by census tracts in Ohio

Characteristic	Prevalence (% Census Tracts)			Median Tobacco Retailer Density (per 1000 people)		
	2017	2022	% change	2017	2022	% change
African American						
High prevalence[a]	26.7	26.6	**-0.5**	1.18	1.15	**-2.5**
Low prevalence	73.3	73.4	0.2	0.92	0.91	**-1.3**
Hispanic						
High prevalence[b]	4.1	4.9	17.7	1.55	1.32	**-14.7**
Low prevalence	95.9	95.1	**-0.8**	0.97	0.95	**-2.5**
Under 18 population						
High prevalence[c]	31.7	29.4	**-7.5**	0.95	0.88	**-6.6**
Low prevalence	68.3	70.6	3.4	1.02	1.00	**-2.2**
Poverty						
High prevalence[d]	42.9	38.0	**-11.4**	1.32	1.29	**-2.2**
Low prevalence	57.1	62.0	8.6	0.80	0.82	2.1
Neighborhood type[e]						
Urban	31.0	31.0	N/A	0.93	0.92	**-0.8**
Suburban	45.1	45.1	N/A	0.95	0.92	**-3.2**
Rural	23.9	23.9	N/A	1.12	1.13	0.3
Tobacco retailer licensing[f]						
Yes	0.0	13.7	N/A	0.98	0.91	**-6.6**
No	100.0	86.3	N/A	1.00	0.97	**-2.8**

[a] Tracts where 15% or more of the population is African American.
[b] Tracts where 15% or more of the population is Hispanic.
[c] Tracts where 25% or more of the population is under age 18.
[d] Tracts where more than 15.4% of the population is below the poverty level (15.4% is the state average for Ohio at baseline).
[e] Classification of urban, rural, and suburban is derived from the 2013 National Center for Health Statistics Urban-Rural Classification Scheme for Counties. Thus, the prevalence cannot change between 2017 and 2022.
[f] Tracts of cities in Ohio which passed a local tobacco retailer license ordinance between 2017 and 2022.
N/A = Not applicable. Change scores were not calculated.
Note: Sociodemographic data were drawn from the American Community Survey (ACS) in 2016 (paired with 2017 retailer data) and 2022 (paired with the 2022 data). The median tract population of 3575 in 2022 was slightly higher than the median tract population of 3535 in 2017 (the total population in Ohio increased by approximately 88 000 from 2017 to 2022).
Numbers in **BOLD** indicate a decrease from 2017 to 2022.

In both 2017 and 2022, there was significantly lower TRD in tracts with a high (vs low) prevalence of people under 18 and greater TRD in tracts with high (vs low) poverty. The children × poverty interaction indicated that the association between TRD and poverty was particularly pronounced where there was a high prevalence of children.

Tobacco Retailer Licensing

In terms of the impact of tobacco retailer licensing, we observed that tracts with tobacco retailer licensing (13 cities, or 430 tracts) showed a greater decrease in TRD (6.6%) vs those tracts that did not have tobacco retailer licensing (2.8%; Table 2). In our second marginal model (Table 3, Model 2), which included tobacco retailer licensing as a factor, the estimated term for the tobacco retailer licensing policy effect was not statistically significant. Overall, patterns between our first model (without the tobacco retailer licensing term) and our second model (with the tobacco retailer licensing term) were very similar; the only major difference was that the effect of suburban tracts was no longer significant in the second model.

Regardless of racial or ethnic composition, high-poverty urban and suburban tracts with tobacco retailer licensing experienced a significant decrease in TRD (Figure 2). While there is a suggestion that the TRD may have decreased for other communities with tobacco retailer licensing, the decrease was not statistically significant.

DISCUSSION

This paper observed a 1.77% decline between 2017-2022 in TRD for Ohio overall. However, the rate of TRD decline was greater for some communities than others. Specifically, TRD declined the most for tracts with a high prevalence of Hispanic individuals and a high prevalence of children (ie, population under the age of 18). There were also some modest declines for tracts with a high prevalence of poverty and a high prevalence of African American individuals. Thus, the degree of TRD disparities was attenuated for these communities, but not eliminated; indeed, our marginal model indicates TRD was still associated with the poverty, race and ethnicity, age, and rurality of an area's residents in 2022. These present findings somewhat align with previous US data, which found poverty-based TRD disparities declined over time, but racial and ethnic-based disparities remained unchanged.[23] Whether any of the equitable declines in Ohio constitute meaningful change for the communities is difficult to determine. But there is evidence that even moderate differences in TRD (eg, 0 vs >5 retailers in an area) are associated with differences in smoking prevalence.[31]

Table 3. Parameter Estimates (and standard errors) from Two Marginal Models Relating 2017 and 2022 Tobacco Retailer Density (TRD) to Sociodemographic Variables, while accounting for Spatiotemporal Dependence

Factor	Model coefficient (standard error)	
	2017	2022
Model 1		
Intercept	**-0.244 (0.040)**	**-0.233 (0.039)**
High prevalence of African American	**0.138 (0.045)**	**0.101 (0.045)**
High prevalence of Hispanic	**0.221 (0.080)**	**0.175 (0.074)**
Neighborhood type		
Suburban vs Urban	0.070 (0.041)	**0.092 (0.041)**
Rural vs Urban	**0.264 (0.050)**	**0.306 (0.050)**
High prevalence of children	**-0.325 (0.050)**	**-0.355 (0.047)**
High prevalence of poverty	**0.443 (0.042)**	**0.376 (0.042)**
Poverty × children interaction	**0.165 (0.069)**	**0.248 (0.070)**
Model 2: Tobacco retailer licensing term added		
Intercept	**-0.244 (0.040)**	**-0.191 (0.045)**
High prevalence of African American	**0.138 (0.045)**	**0.106 (0.045)**
High prevalence of Hispanic	**0.221 (0.080)**	**0.161 (0.074)**
Neighborhood type:		
Suburban vs Urban	0.070 (0.041)	0.049 (0.048)
Rural vs Urban	**0.264 (0.050)**	**0.263 (0.055)**
High prevalence of children	**-0.325 (0.050)**	**-0.356 (0.047)**
High prevalence of poverty	**0.443 (0.042)**	**0.380 (0.042)**
Poverty × children interaction	**0.165 (0.069)**	**0.251 (0.070)**
Tobacco retailer licensing	-	-0.104 (0.060)

Note: **BOLD** font indicates effects are significantly different from zero, with significance level 0.05.

Whereas TRD declined in suburban areas, there was no indication that TRD was declining equitably for rural areas. These findings underscore how progress toward equity does not always advance at the same rate for all populations. It is encouraging to see TRD disparities reduced for areas with high poverty and a high prevalence of racial or ethnic minority individuals. However, it is concerning that no such declines occurred for rural areas. In fact, our modeling indicates rurality is one of the strongest predictors of TRD. There are many potential reasons for this continuing rural disparity. As discussed below, support and capacity for local tobacco control policy likely plays a role. Another potential factor is the predatory nature of certain tobacco retailer chains. For example, discount stores (or "dollar stores") are more highly concentrated in rural areas[32] and are one of the only types of tobacco retailers whose numbers continue to increase.[14]

This study also observed some evidence of an equitable decline in TRD in locations that implemented tobacco retailer licensing. The TRD significantly declined in high-poverty urban and suburban areas with (vs without) tobacco retailer licensing. Such outcomes support statements by tobacco control advocates that tobacco retailer licensing could be an equitable strategy for reducing TRD.[19,21] The outcomes also align with research emerging from other areas of the United States[33,34] pointing to real-world equitable effects of tobacco retailer licensing. This promising finding arrives at a difficult time for Ohio, as state legislators approved state preemption of all local tobacco policies in early 2024,[35] effectively erasing the benefits of local tobacco retailer licensing. Even more recently, public health champions won a lawsuit arguing this preemption law violated the state constitution, meaning local policy is again allowed—but only for the (mostly urban) localities that were part of the lawsuit.[36] Consequently, we may see the public health benefits of tobacco retailer licensing continue to grow for these primarily urban communities.

It is noteworthy that nearly all tobacco retailer licensings enacted in Ohio were in urban or suburban areas. Thus, it is likely we did not detect an effect of tobacco retailer licensing in rural areas because we have no statistical power to do so. Statistical power may also explain why we did not detect an overall effect of tobacco retailer licensing in our marginal models. This policy-based disparity in tobacco retailer licensing may have also contributed to our finding, discussed above, that TRD disparities did not decline for rural tracts. Unfortunately, rural areas are often left behind in policy innovation, as they frequently lack the capacity needed to

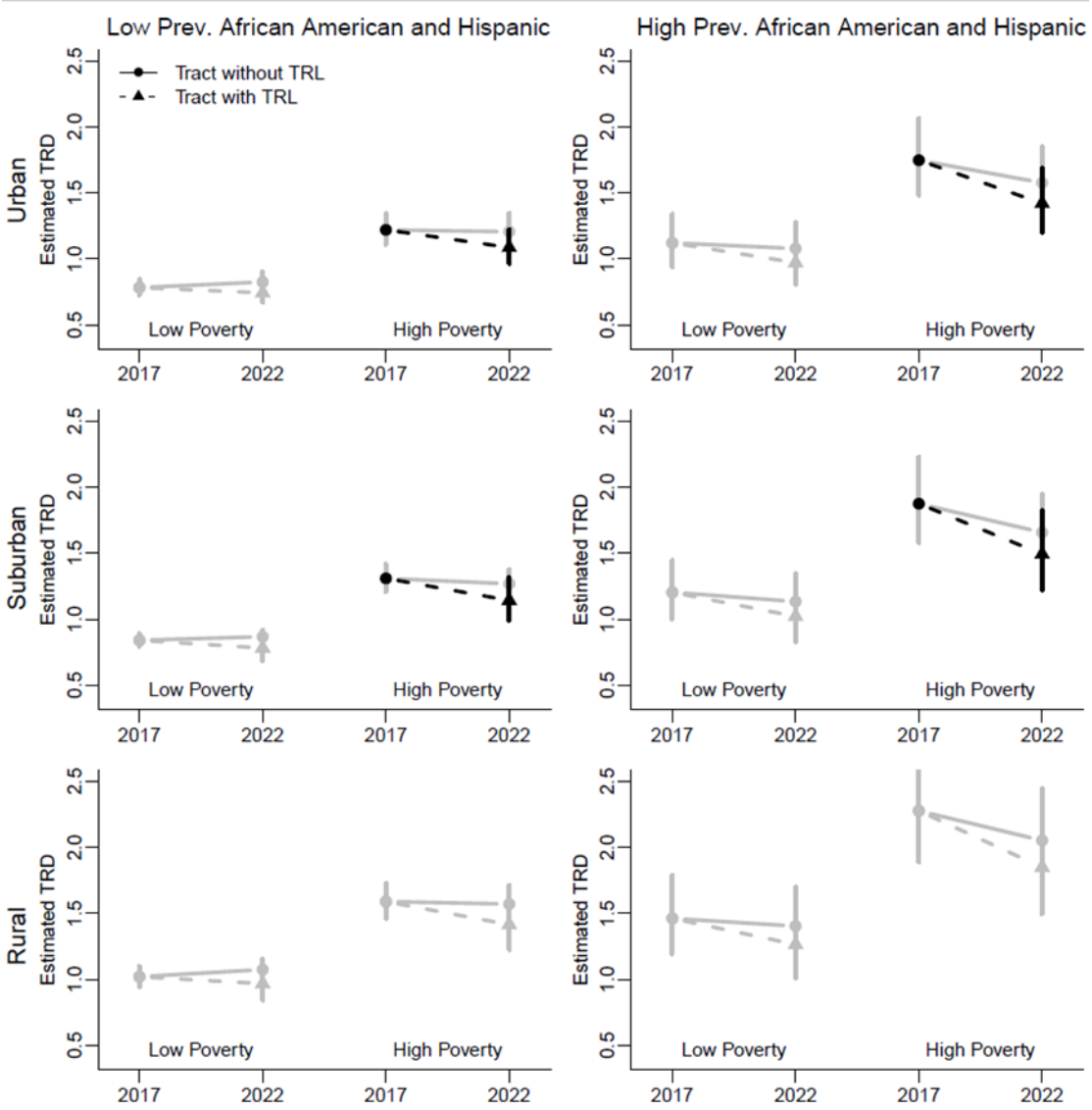


Figure notes: Dashed lines indicate tracts with a tobacco retailer license policy.
Solid lines indicate tracts without a tobacco retailer license policy.
Lines colored black indicate a significant difference between 2017 and 2022.
Gray lines are not significant.
Error bars indicate 95% confidence intervals.

Figure 2. Estimated Tobacco Retailer Density for Census Tracts Grouped by Sociodemographic Variables and Year

successfully introduce tobacco control policies, contributing to disparities in tobacco use.[37,38]

Limitations to the present study should be acknowledged. Our analysis used dichotomized covariates and there may be nonlinear models that describe the relationship between TRD and the sociodemographic covariates when dichotomization is not used. Our data came from just one US state, and additional research will be needed to determine whether the present outcomes generalize to other states or countries. Our data also captured a time period made distinctive by the COVID-19 pandemic; while critical to capture, the trends and patterns observed may not extend to future years. Our investigation with tobacco retailer licensing should also be interpreted with caution, given the somewhat low prevalence of tobacco retailer licensing investigated (13 cities, comprising 13.7% of the state's tracts).

PUBLIC HEALTH IMPLICATIONS

The present findings indicate little overall change in Ohio's TRD over a 5-year period. Depending on the type of community, there were some equitable declines in TRD, which is encouraging. However, our modeling indicates the TRD of an area is still significantly associated with the poverty, race and ethnicity, age, and rurality of its residents. Based on these findings, and knowing that disparities in TRD are associated with disparities in tobacco use,[7] it is likely that tobacco-related health concerns will continue to disproportionately impact high-poverty individuals, racial and ethnic minority individuals, and rural individuals in Ohio.

Findings from this study can inform other localities considering retailer-based policies. To precipitate more drastic change in TRD, tobacco retailer licensing could be supplemented with licensing-law strategies, such as restricting retailers from being close to schools or capping the number of retailers allowed in a county,[39] which will likely yield equitable effects.[33,40,41] Policy makers may also wish to consider even stronger licensing approaches, such as age-restricted location policies. Traditional approaches to addressing the retail environment, such as enforcement of minimum-age-of-sale laws, also require continued focus. Throughout these efforts, particular attention should be paid to policy implementation in rural areas, as these are among the communities most disadvantaged by TRD, while simultaneously the least served by retailer-based tobacco control. Rather than leaving the decision to pass tobacco retailer licensing to local officials, state-level policies may be necessary to ensure equitable, comprehensive coverage.

CONFLICTS OF INTEREST

None of the authors report a conflict of interest.

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AUTHOR CONTRIBUTION

Megan Roberts and Peter Craigmile conceptualized the study. Abby Shores assisted in data curation and validation. Wendy Hyde assisted in data curation. Rui Qiang and Peter Craigmile conducted the analyses and created the visualizations. Rui Qiang, Peter Craigmile, and Megan Roberts wrote the original draft. All authors reviewed and edited the manuscripts/drafts.

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APPENDIX

This Appendix describes how we define the temporally-varying sociodemographic variables on a common set of (2021) census tracts. We then provide details on the spatiotemporal statistical model that we assume for establishment counts over space and time. This generalizes the spatial model of Adibe et al[1] to spatiotemporal models. We also give an estimate of the covariance of the regression parameters using a sandwich estimator. See Figure S2.

S1 Procedure for configuring sociodemographic variables across 2 timepoints on a single set of census tracts
The shapefile for 2022 was not available when our tobacco retailer data were collected; therefore, our analysis is based on the 2021 shapefile. From 2017–2021, the tracts in Ohio changed, and the number of tracts increased from 2952 to 3168. Our analysis used 2021 tract configurations. To obtain a common set of sociodemographic variables on the same spatial scale over the 2 time points, we mapped the 2017 American Community Survey (ACS) demographic variables to the 2021 tracts by comparing the area of overlap in the 2017 and 2021 tracts. To calculate the 2017 population in each of the 2021 tracts, we re-weighted the 2017 populations by the proportion of areas of the 2017 tracts that overlapped with the 2021 tracts. For all other sociodemographic variables, we defined the 2017 ACS values for each 2021 tract as being the value found in the 2017 tract that had the greatest overlapping area with the 2017 tract. This process generated 2017 and 2022 ACS sociodemographic values defined on a common set of (2021) tracts.

S2 Defining the spatiotemporal model
Suppose that $i = 1, \ldots, m$ indexes the m census tracts in Ohio, and let t denote the time index (in this application t = 1 denotes 2017 and t = 2 denotes 2022, but the model can allow for more than 2 time points). Let Y_{it} denote the number of establishment counts in census tract i and year t with P_{it} denoting the population of tract i in thousands for year t. Let $\boldsymbol{x}_{it}$ be a vector of covariates for each census tract i and time point t of length p_t, and $\boldsymbol{\beta}_t$ denote regression coefficients for each time point t. In our marginal model we assume that Y_{it} are spatially and temporally correlated with mean

$$\mu_{it} = \mathrm{E}(Y_{it}) = P_{it} \exp(\boldsymbol{x}_{it}^T \boldsymbol{\beta}_t), \quad \text{(S1)}$$

variance

$$V_t(\mu_{it}) = var(Y_{it}) = \frac{\sigma_t^2}{1-\phi^2}\left[\mu_{it} + \frac{\mu_{it}^2}{\theta_t}\right], \quad \text{(S2)}$$

and covariance

$$cov(Y_{it}, Y_{i't'}) = \sqrt{V_t(\mu_{it}) V_{t'}(\mu_{i't'})} R_{ii'} \, \phi^{|t-t'|}.$$

Here $\theta_t > 0$ is an overdispersion parameter that can vary in time, $\sigma_t^2 > 0$ is a variance parameter that can also vary in time, ϕ is a temporal dependence parameter that lies between −1 and 1, and $R_{ii'}$ is the (i, i') element of a $m \times m$ spatial correlation matrix $\boldsymbol{R}$ that corresponds to assuming a conditional autoregressive (CAR) spatial model (eg Banerjee et al[2]) across the m census tracts. We assume that $\boldsymbol{R}$ is defined by

$$\boldsymbol{R} = (\boldsymbol{D} - \alpha \boldsymbol{W})^{-1}, \quad \text{(S3)}$$

where $\boldsymbol{W}$ is a $m \times m$ spatial proximity matrix with (i, i') element equal to one if tract i and tract i' share a border, and zero otherwise. The diagonal elements of $\boldsymbol{W}$ are assumed to be zero. The $m \times m$ matrix $\boldsymbol{D}$ is a diagonal matrix with ith diagonal element equal to the number of census tracts that share a border with census tract i. In (S3), the parameter α denotes a spatial dependence parameter that lies between −1 and 1 and does not vary with time.
We use a generalized estimating equation (GEE) methodology to fit our model. We first fit negative binomial generalized linear models to the establishment counts across the m census tracts for each year t: for each time point t we fit a generalized linear model assuming (S1) and (S2), assuming independence over the different census tracts. We then perform statistical inference on the regression parameters $\boldsymbol{\beta}_t$ over time indexes t using a sandwich estimator that uses the spatiotemporal correlations assumed in (S3).
In terms of model building, starting with the covariates and interactions, we used Wald tests to simplify the model, leaving terms that were jointly significantly different from zero while accounting for the spatiotemporal dependence.

S3 Estimating the covariance matrix for the regression parameters
Let $\boldsymbol{Y}_t = (Y_{1t}, \ldots, Y_{mt})^T$ denote the vector of establishment counts for time point t and $\boldsymbol{X}_t$ denote the $m \times p_t$ design matrix with ith row equal to the covariate vector $\boldsymbol{x}_{it}$ for census tract i at time point t. Let $\boldsymbol{G}_t$ be an $m \times p_t$ matrix with (i, j) element $\mu_{it}[\boldsymbol{x}_{it}]_j$, and let $\boldsymbol{J}_t = \boldsymbol{G}_t^T \boldsymbol{V}_t^{-1} \boldsymbol{G}_t$ where $\boldsymbol{V}_t = \mathrm{diag}(V_t(\mu_{it}) : i = 1, \ldots, m)$ is the $m \times m$ working covariance matrix assuming independence over space for each time point t. Then, the sandwich estimator for the covariance of the estimated regression parameter $\widehat{\boldsymbol{\beta}}_t$ at time point t is

$$\mathrm{cov}(\widehat{\boldsymbol{\beta}}_t) = \boldsymbol{J}_t^{-1} \boldsymbol{G}_t^T \boldsymbol{V}_t^{-1} \mathrm{cov}(\boldsymbol{Y}_t) \boldsymbol{V}_t^{-1} \boldsymbol{G}_t \boldsymbol{J}_t^{-1}$$

and the covariance between regression parameters at different time points t and t' is

$$\mathrm{cov}(\widehat{\boldsymbol{\beta}}_t, \widehat{\boldsymbol{\beta}}_{t'}) = \boldsymbol{J}_t^{-1} \boldsymbol{G}_t^T \boldsymbol{V}_t^{-1} \mathrm{cov}(\boldsymbol{Y}_t, \boldsymbol{Y}_{t'}) \boldsymbol{V}_{t'}^{-1} \boldsymbol{G}_{t'} \boldsymbol{J}_{t'}^{-1}.$$

The spatial and temporal dependence parameters α and ϕ are estimated from the Pearson residuals for all census tracts and time points using maximum likelihood (ML). With these estimates, our estimated covariance of the estimated regression parameter $\widehat{\boldsymbol{\beta}}_t$ at time point t is

$$\widehat{\text{cov}}(\hat{\boldsymbol{\beta}}_t) = \boldsymbol{J}_t^{-1}\boldsymbol{B}_t^T\left[\frac{\hat{\sigma}_t^2}{1-\hat{\phi}^2}\right](\boldsymbol{D}-\hat{\alpha}\boldsymbol{W})^{-1}\boldsymbol{B}_t\boldsymbol{J}_t^{-1}$$

with the estimated covariance between the parameters at 2 different time points *t* and *t'* being

$$\widehat{\text{cov}}(\hat{\boldsymbol{\beta}}_t, \hat{\boldsymbol{\beta}}_{t'}) = \boldsymbol{J}_t^{-1}\boldsymbol{B}_t^T\left[\frac{\hat{\phi}\,\hat{\sigma}_t\,\hat{\sigma}_{t'}}{1-\hat{\phi}^2}\right](\boldsymbol{D}-\hat{\alpha}\boldsymbol{W})^{-1}\boldsymbol{B}_{t'}\boldsymbol{J}_{t'}^{-1},$$

where $B_t = \text{diag}\left(\frac{\widehat{\mu_{it}}}{\sqrt{V_t(\widehat{\mu_{it}})}} : i = 1, \ldots, m\right)\boldsymbol{X}_t$, for each time point *t*.

S4 Census tracts affected by tobacco retailer licensing policies between 2017 and 2022

Figure S1 displays a map of Ohio indicating the census tracts in blue affected by the enactment of tobacco retailer licensing policies between 2017 and 2022.

Figure S1 Ohio tobacco retailer licensing policies

S5 Tobacco Retailer Density (TRD) Ratios

Table S1 tabulates TRD ratios from 2 marginal models relating 2017 and 2022 TRD to sociodemographic variables, while accounting for spatiotemporal dependence.

For example, in Model 1 we estimate that in Ohio in 2017 the TRD density is 1.25 times higher for census tracts with a high prevalence of Hispanic vs census tracts with a low prevalence of Hispanic. A 95% confidence interval for this factor is between 1.07 and 1.46.

Table S1 The TRD ratios from 2 marginal models relating 2017 and 2022 TRD to sociodemographic variables, while accounting for spatiotemporal dependence. The numbers in parentheses are 95% confidence intervals for the ratios.

Factor	TRD Ratio (95% CI)	
	2017	2022
Model 1		
High prevalence of African American	**1.15 (1.05,1.25)**	**1.11 (1.01,1.21)**
High prevalence of Hispanic	**1.25 (1.07,1.46)**	**1.19 (1.03,1.38)**
Neighborhood type:		
Suburban vs Urban	1.07 (0.99,1.16)	**1.10 (1.01,1.19)**
Rural vs Urban	**1.30 (1.18,1.44)**	**1.36 (1.23,1.5)**
High prevalence of children	**0.72 (0.66,0.80)**	**0.07 (0.64,0.77)**
High prevalence of poverty	**1.56 (1.43,1.69)**	**1.46 (1.34,1.58)**
Poverty × children interaction	**1.18 (1.03,1.35)**	**1.28 (1.12,1.47)**
Model 2		
High prevalence of African American	**1.15 (1.05,1.25)**	**1.11 (1.02,1.21)**
High prevalence of Hispanic	**1.25 (1.07,1.46)**	**1.17 (1.02,1.36)**
Neighborhood type:		
Suburban vs Urban	1.07 (0.99,1.16)	1.05 (0.96,1.15)
Rural vs Urban	**1.30 (1.18,1.44)**	**1.30 (1.17,1.45)**
High prevalence of children	**0.72 (0.66,0.80)**	**0.70 (0.64,0.77)**
High prevalence of poverty	**1.56 (1.43,1.69)**	**1.46 (1.34,1.58)**
Poverty × children interaction	**1.18 (1.03,1.35)**	**1.29 (1.12,1.47)**
Tobacco retailer licensing	–	0.90 (0.80,1.01)

Bold font indicates effects are significantly different from 0.

S6 Local indicators of spatial association (LISA)

Using the sfweights R package (https://github.com/JosiahParry/sfweight), we ran a LISA analysis (Anselin[3]) using the local Moran's I statistic calculated for the log TRD for each year (2017 and 2022), using the same spatial neighborhood structure as we used in the spatial model. This version of the analysis classifies census tracts into 4 categories:

1. HH: high values surrounded by high values;
2. HL: high values nearby other low values;
3. LH: low values nearby other high values;
4. LL: low values nearby other low values.

Plots of the categories, by tract, for each year are shown in Figure S2. To investigate general trends, Table S2 shows a percentage breakdown of the categories jointly over the 2 years. Figure S2 and TableS2 suggest that for both years, high log TRD values surrounded by high log TRD values (HH) is the most common situation in both 2017 (33.1% of the time) and 2022 (33.2% of the time), and that this category tends to occur in urban, suburban, and rural areas. Low log TRD values nearby other low log TRD values (LL) is less common (23.4% of the time in 2017 and 22.6% of the time in 2022). Figure S2 and further calculation indicate that this category is less likely in rural areas.

While a test of association rejects the null hypothesis of independence between the categories in 2017 and 2022, with a p value close to zero, Figure S2 and Table S2 provide no persuasive evidence that the distribution of these categories have changed greatly over these years. The clusters of categories differ slightly, but a general pattern of change is not consistent from 2017 to 2022.

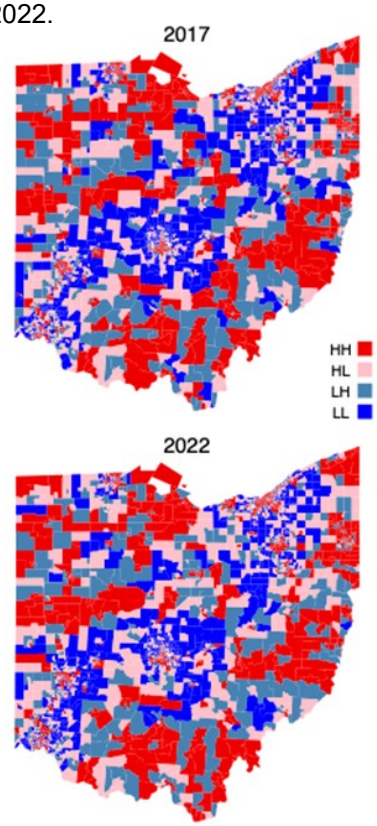

Figure S2: A map of Ohio in 2017 and 2022 indicating the clustering of log retailer rates for each census tract, as determined by calculating LISA. See text for further detail.

Table S2: A percentage breakdown of the LISA categories broken down over the 2 years, 2017 and 2022.

		2022			
		HH	HL	LH	LL
2017	HH	27.0	3.1	2.5	0.5
	HL	3.1	18.8	0.3	2.8
	LH	2.5	0.3	14.2	1.5
	LL	0.6	3.1	1.9	17.8

S7 Assessing the impact of retailer enforcement

To evaluate the possible role of retailer enforcement in our models for relating TRD to sociodemographic variables, we obtained data from the US Food and Drug Administration (FDA) on compliance check inspections of brick-and-mortar tobacco product retailers (downloaded from https://timp-ccid.fda.gov/). We pulled data from all FDA led inspections in Ohio during the year 2017, and again during the year 2022. There were 5251 inspections in 2017 and 3005 inspections in 2022. By county in Ohio, the number of inspections ranged from 1 to 175 in 2017, and from 0 to 974 in 2022.

For each census tract we calculated the number of inspections in 2017 per thousand people in the county that contains each census tract. We repeated the calculation for the number of inspections in 2022 per thousand people. There was no evidence of a linear relationship between these 2 covariates and the observed log retailers rates (we observed correlations with the observed log retailer rate of 0.051 for the 2017 inspections variable, and 0.046 for the 2022 inspections variable). Regardless, we added these 2 variables to Model 2 from the main article (Model 2 in-

cludes both the sociodemographic variables and a tobacco retailer licensing term.) A summary of the model in show in Table S3. This table illustrates that neither inspection variable was significant in our statistical model. Further, the estimated coefficients and associated standard errors hardly changed for the sociodemographic and tobacco retailer variables, indicating that when using these measures of retailer enforcement, there was no impact upon our findings.

Table S3: Parameter estimates from a marginal model relating 2017 and 2022 TRD to sociodemographic variables, while accounting for spatiotemporal dependence. This model includes covariates that measure the rate of inspections in 2017 and 2022, as well as a tobacco retailer licensing term in 2022. The numbers in parentheses are standard errors.

Factor	Model coefficient (standard error) 2017	2022
Model 3: Inspections in 2017 and 2022 and tobacco retailer licensing added		
Intercept	**-0.244 (0.040)**	**-0.191 (0.045)**
High prevalence of African American	**0.138 (0.045)**	**0.106 (0.045)**
High prevalence of Hispanic	**0.224 (0.080)**	**0.163 (0.074)**
Neighborhood type:		
Suburban vs Urban	0.059 (0.043)	0.036 (0.049)
Rural vs Urban	**0.246 (0.053)**	**0.252 (0.056)**
High prevalence of children	**-0.324 (0.050)**	**-0.352 (0.047)**
High prevalence of poverty	**0.443 (0.042)**	**0.380 (0.042)**
Poverty × children interaction	**0.163 (0.069)**	**0.246 (0.070)**
Tobacco retailer licensing		-0.104 (0.060)
Inspection rate	0.057 (0.056)	0.100 (0.089)

Bold font indicates effects are significantly different from 0.

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RESEARCH ARTICLE

The Impact of the Five Domains of Social Determinants of Health on Resilience Among Postpartum Women in Dayton, Ohio

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ABSTRACT

Background: The objective of this study is to utilize patient-reported experiences and publicly available neighborhood social determinants of health (SDoH) characteristics to examine resilience among postpartum women within the 5 domains of SDoH.

Methods: Postpartum women receiving care at a large urban medical center in Ohio from 2017-2019 participated in a 3-part survey. The survey collected demographic information, barriers to care, and agency (confidence in achieving goals) and pathway (ability to identify strategies to achieve goals) resilience scores. Participants were grouped by 1) neighborhood SDoH characteristics, categorized into high- or low-severity based on publicly available zip code data (crime rate, food desert, and poverty level) and 2) self-reported barriers to care marked as problematic at least some of the time. Statistical analyses included t test and analysis of variance (ANOVA).

Results: Responses from 69 participants were analyzed. Participants in high-crime areas had significantly higher agency scores than those in low-crime areas (high = 28.6±3.1 vs low = 26.1±3.5; p=.003). Pathway scores were significantly lower among participants reporting barriers such as food insecurity (problem = 22.3±5.9 vs no problem = 27.0±3.8; p=.008), insufficient time for medical appointments (problem=21.5±6.9 vs no problem=27.0±3.9; p=.01), lack of support from friends (problem=22.7±5.6 vs no problem=27.0±3.9; p=.02), difficulty finding childcare (problem=23.9±5.4 vs no problem=27.2±3.7; p=.02), and feeling overwhelmed by stress (problem=25.6±4.5 vs no problem=27.9±3.5; (p=.02).

Conclusion: These findings emphasize the need for targeted programs addressing SDoH affecting pregnant people in Ohio during the perinatal period. Initiatives should focus on reducing stress, strengthening social support, food security, and resilience-building in urban communities.

Keywords: Social determinants of health; Resiliency; Barriers to care; Pregnancy; Survey design

INTRODUCTION

The impact of social determinants of health (SDoH) on pregnancy outcomes has received increasing attention in recent years. The inverse association between SDoH, prenatal care utilization, and pregnancy outcomes is well-documented.[1–9] The long-term effects of redlining have created geographic areas with overlapping social vulnerabilities. Historically, redlined neighborhoods are linked to poor health outcomes, including high preterm birth and infant mortality rates and low prenatal care initiation.[10,11] Additionally, redlining has shaped racial composition, necessitating an analysis of racism's role in shaping SDoH experiences.[1,5,12] Resilience may serve as a protective factor by mitigating the impact of adverse

circumstances, including SDoH and prenatal stress, on pregnancy outcomes.[13–16] However, few studies have examined resilience in pregnant women within the context of the 5 domains of SDoH and the neighborhood characteristics shaped by redlining.[17]

The inherent overlap makes it difficult for researchers, health care providers, and policymakers to pinpoint specific factors that influence patients' access to health care and their health outcomes.[5,18,19] Interventions addressing SDoH have been shown to improve prenatal care utilization, maternal health behaviors, and maternal and infant outcomes.[1,20] Many SDoH correlate with a patient's zip code, with neighborhood characteristics described through economic variables, crime statistics, segregation data, and assessments of walkability, food availability, and perceived safety.[8,10,21–32]

The Centers for Disease Control and Prevention (CDC) categorizes SDoH into 5 domains: economic stability, education access and quality, health care access and quality, neighborhood and built environment, and social and community context. Each domain encompasses factors that affect health and well-being.[33] Economic stability includes financial status, employment status, food insecurity, and housing instability. Education access and quality refers to the ability to find and use health information and is related to completion of high school, college attendance, spoken language, and literacy. Health care access and quality refers to the ability to access and use health services and includes insurance coverage, access to providers, access to providers with cultural competency and language needs, and factors affecting the ability to access health care. Neighborhood and built environment represents the connection between where a person lives and their health and includes access to healthy food, transportation, safety/crime and violence, walkability, parks, geography/zip code, and air and water quality. Social and community context represents the connection between health and areas where a person lives, works, and plays and includes support systems, community engagement, stress, and discrimination.[33–36]

Pregnancy represents a significant time in a person's life marked by physiologic and hormonal changes, potentially exacerbating both the positive and negative social factors that influence physical and mental health, relationships, work, stress, and financial stability.[14] One study revealed that 84% of pregnant participants experienced stress ranging from low to severe levels.[37] High stress and anxiety are associated with adverse infant health outcomes such as preterm birth, reduced fetal heart rate–movement coupling, increased birth complications, and a higher risk of maternal postpartum depression and anxiety.[38,39]

Resilience, the ability to respond and adapt to stress, varies based on an individual's circumstances and resources. Resilience does not imply invulnerability to stress but rather the capacity to cope with adverse events.[37] Resilience has been quantified using 2 components: agency (confidence in achieving goals) and pathway (ability to identify strategies to achieve goals).[40] Protective factors, including social support, education, youth, and self-efficacy, are associated with higher resilience levels and reduce trauma-related psychopathology, anxiety, depression, and related medical morbidity and mortality.[13,38,39,41,42] Mapping out demographic and socioeconomic factors within a neighborhood tells a story of the specific vulnerabilities to which residents are exposed. As social vulnerabilities differ by individuals, communities, and racial groups, the risk of exposure to adverse events, and the level of resilience required to maintain physical and mental health, varies accordingly.[17,43]

Despite the growing literature about the role of SDoH in health outcomes, gaps remain regarding how individual experiences within specific SDoH domains relate to resilience among pregnant populations. Understanding these relationships is necessary to inform targeted interventions and policies that address the unique challenges faced by postpartum individuals, particularly those living in neighborhoods affected by historical redlining and experiencing structural inequalities. This study aims to address these gaps by examining resilience among postpartum individuals through self-reported experiences and publicly available neighborhood-level data. Using the CDC's 5 SDoH domains as a framework, this study investigates how neighborhood characteristics and personally experienced barriers to care relate to resilience among postpartum women.

METHODS

Data and Participants

This study was conducted using a 3-part survey given to postpartum patients at a southwestern Ohio medical center between 2017 and 2019. Patients were eligible for inclusion if they were 18 years or older and could read English. The survey included a consent cover letter, questions about demographic information, different barriers to care they may or may not have experienced, and a resiliency questionnaire. The study team entered survey responses into Research Electronic Data Capture (REDCap).[44] The study was approved by the Wright State University institutional review board (#6114).

Measures

Resilience was measured using Snyder's cognitive model of hope questionnaire, which generates agency and pathway scores.[40] Scores are continuous variables ranging from 4 to 32, with higher scores indicating greater hope or resilience.

Neighborhood characteristics were coded using the 2014 Montgomery County Health Assessment (CHA), the most recent dataset available for specific zip codes.[11] Characteristics were categorized as low- or high-severity based on CHA ratings for poverty (the percent of the population living below the poverty level), crime (rates of crime per 1000 residents), food desert (low-income census tract areas where a large number of people live more than a mile from the nearest supermarket), no prenatal care (the percent

of women with no prenatal care in the first trimester), and infant mortality (number of infant deaths per 1000 live births) (Table 1).

Barriers to care included transportation (being able to get to places), food security (having enough to eat), finances (having enough money), stress (feeling overwhelmed by stress), lack of social support (having family support, having friend support), childcare availability (finding childcare), fatigue (feeling tired all the time), and insufficient time for doctor visits. Each barrier was coded as a binary variable (yes or no) based on whether participants identified it as problematic at least some of the time.

Demographic data, barriers to care and neighborhood characteristics were categorized into the 5 domains of SDoH. Economic stability included the CHA Poverty ratings and barriers to care related to money and food insecurity. Education access and quality included highest education level completed. Health care access and quality included type of insurance, the timing of prenatal care initiation, car ownership, barriers related to car ownership, barriers related to transportation and time for medical visits, and CHA ratings for no prenatal care and infant mortality. Neighborhood/built environment included length of residence in their current zip code, CHA ratings for crime and food desert status. Social/community context included barriers related to family and friend support, childcare availability, overwhelming stress, and fatigue.

Statistical Analysis

Participants were grouped by severity of the neighborhood characteristics and self-reported barriers to care. Demographic characteristics, neighborhood characteristics, and barriers to care were compared by race using chi-square tests for categorical variables and analysis of variance (ANOVA) for continuous variables. Resilience scores were compared by severity of the neighborhood characteristic and barriers to care using t test and ANOVA to control for race. Statistical significance was defined as $p < .05$. All analysis was performed using SPSS Version 29.0 (IBM, Armonk, NY).

RESULTS

Overall, 114 surveys were completed during the study period. Responses from participants residing in Montgomery County, Ohio, were coded for neighborhood characteristics, resulting in 69 surveys included for analysis. The cohort was diverse in race, marital status, age, and education (Table 2). Most participants identified as White (50%), while 36% identified as Black, and 13% identified as other races including Hispanic, Asian, mixed race, or other. Racial groups were similar in age, type of transportation used for prenatal care visits, number of children, resilience scores, and the presence of barriers to care. However, significant differences were observed across racial groups for marital status ($p = .005$), education level ($p = .03$), and type of health insurance ($p < .001$).

Tables 3 and 4 present data with Column 1 representing low-severity categories (eg, low crime rates, barriers not identified as problematic, higher education levels, living with others), which are expected to have minimal impact on resilience scores. Column 2 represents high-severity categories (eg, high crime rates, problematic barriers, lower education levels, living alone) which are expected to have a greater impact on resilience scores.

Resiliency score comparisons for demographic characteristics, neighborhood characteristics, and barriers to care were conducted using ANOVA (controlling for race) and t tests (without controlling for race). Across all comparisons, racial group did not account for a significant amount of variance, and p values were not statistically significant. In some cases, the number of participants in certain racial categories was insufficient to yield reliable results. As a result, Tables 3 and 4 report values based on t test comparisons without controlling for race.

Resilience and Economic Domain

Agency and pathway resilience scores did not differ by the severity of poverty or by participants reporting problems with having enough money (Table 3). However, pathway resilience scores were significantly lower among participants who reported problems with having enough to eat (problem = 22.3 ± 5.9) compared to those who did not report this as an issue (no problem = 27.0 ± 3.8; $p = .008$).

Resilience and Education Access and Quality Domain

Agency and pathway resilience scores did not differ among participants with lower levels of education (high school or less) and those with higher education levels (some college or more) (Table 3).

Resilience and Health care Access and Quality Domain

Agency and pathway resilience scores did not differ based on the type of insurance, self-reported initiation of prenatal care during the first trimester, car ownership, or problems with transportation. Similarly, no differences in agency and pathway scores were observed among participants living in neighborhoods with high versus low rates of no prenatal care in the first trimester or neighborhoods with high versus low rates of infant mortality (Table 3). However, pathway resilience scores were significantly lower for participants reporting problems with having enough time to visit

Table 1. Coding for Severity of Neighborhood Characteristics

Vulnerability	Coded as low-severity			Coded as high-severity	
Poverty (%)	0-1.6	1.7-2.6	2.7-3.7	3.8-5.6	5.7-8.9
Crime	5.8-8.0	8.1-19.0	19.1-33.3	33.4-68.9	69.0-120
Food desert	No			Yes	
No prenatal care (%)	8.9-13.8	13.9-20.4	20.5-25.0	25.1-30.3	30.4-35.2
Infant mortality	0.0-2.3	2.4-6.8	6.9-13.4	13.5-21.7	21.8-76.9

the doctor (problem = 21.5 ± 6.9) compared to those who did not identify this as an issue (no problem=27.0 ± 3.9; p = .01).

Resilience and Neighborhood/Built Environment Domain

Agency and pathway resilience scores did not differ among participants who reported living in their current neighborhood for less than 2 years compared to those living there for more than 2 years. Similarly, no differences were observed between participants living in a food desert and those not living in a food desert (Table 4). Agency resilience scores were significantly higher for participants living in neighborhoods with high crime rates (high crime=28.6 ± 3.1) compared to those living in neighborhoods with low crime rates (low crime = 26.1 ± 3.5; p = .003).

Resilience and Social/Community Context Domain

Agency and pathway resilience scores did not differ among participants living alone versus those living with others or among participants reporting involvement of the baby's father versus those reporting no involvement. Similarly, no differences were observed among participants reporting problems with family support and those without such problems (Table 4). Pathway resilience scores were significantly lower for participants reporting problems with friend support (problem = 22.7 ± 5.6) compared to those without such problems (no problem = 27.0 ± 3.9; p = .02). Pathway resilience scores were also significantly lower for participants reporting difficulties finding childcare (problem = 23.9 ± 5.4) compared to those without such difficulties (no problem = 27.2 ± 3.7; p = .02). Participants overwhelmed by stress had significantly lower agency resilience scores (problem = 26.7 ± 3.7) compared to those not reporting stress as a problem (no problem = 28.9 ± 2.7; p = .005). Pathway resilience scores were also significantly lower for participants overwhelmed by stress (problem = 25.6 ± 4.5) compared to those who were not (no problem = 27.9 ± 3.5; p = .02). Agency and pathway resilience scores did not differ for participants who reported being too tired for everyday activities compared to those who did not.

DISCUSSION

Among the 5 domains of social determinants of health (SDoH), we found lower pathway resilience scores in the high-severity categories for problems such as having enough to eat (economic), having enough time to go to the doctor (health care), and having sufficient friend support, finding childcare, and feeling overwhelmed by stress (social/community context). Conversely, higher agency resilience scores were observed in neighborhoods with high crime rates (neighborhood/built environment), while lower agency scores were linked to feeling overwhelmed by stress (social/community context). These findings align with existing literature which associates higher resilience with neighborhood crime and lower resilience with diminished social support.[13–15,27]

Table 2. Demographic Characteristics, Severity of Neighborhood Characteristics, and Barriers to Care by Racial Group

		Black (N=25)	White (N=35)	Other Races (N=9)	P
Age (in years)	18-27	18 (72%)	18 (51%)	5 (56%)	.56
	28-34	5 (20%)	14 (40%)	3 (33%)	
	35+	2 (8%)	3 (9%)	1 (11%)	
Marital status	Single	20 (80%)	12 (34%)	5 (33%)	.005
	Married	5 (20%)	22 (63%)	3 (56%)	
	Divorced	0	1 (3%)	1 (11%)	
Highest level of education	High school degree or less	16 (64%)	9 (26%)	6 (67%)	.03
	Some college	6 (24%)	17 (49%)	2 (22%)	
	4 or more years college	3 (12%)	9 (26%)	1 (11%)	
Type of health insurance	Private insurance	4 (16%)	17 (49%)	4 (44%)	<.001
	Medicaid	21 (84%)	16 (46%)	1 (11%)	
	Self-pay	0	2 (6%)	4 (44%)	
Transportation to prenatal care	Own car	16 (67%)	32 (91%)	8 (89%)	.20
	Ride with family/friend	4 (17%)	2 (6%)	1 (11%)	
	Public transportation	2 (8%)	0	0	
	Walk	0	1 (3%)	0	
	Insurance provided ride	2 (8%)	0	0	
Number of children		2.1 ± 1.3	1.9 ± 1.3	2.9 ± 1.3	.14
Number years living in current zip code		5.4 ± 7.7	6.3 ± 8.8	7.1 ± 7.3	.86
Resiliency score	Agency	27.8 ± 3.6	27.5 ± 3.5	27.7 ± 3.3	.95
	Pathway	25.9 ± 4.7	26.8 ± 4.1	27.8 ± 3.3	.49
Neighborhood vulnerability (high-severity)	Poverty	15 (60%)	7 (20%)	4 (44%)	.006
	Crime	20 (80%)	15 (45%)	5 (56%)	.03
	Food desert	11 (44%)	6 (17%)	1 (11%)	.04
	No prenatal care	20 (80%)	6 (17%)	3 (33%)	<.001
	Infant mortality	8 (32%)	1 (3%)	0	.003
Barrier to care (IS a problem)	Getting places	6 (24%)	3 (9%)	2 (22%)	.24
	Having enough to eat	6 (24%)	0	0	.003
	Having enough money	8 (32%)	5 (14%)	2 (22%)	.26
	Feeling overwhelmed by stress	18 (72%)	15 (43%)	4 (44%)	.07
	Having family support	6 (24%)	0	1 (11%)	.01
	Having friend support	5 (20%)	0	1 (11%)	.03
	Finding childcare	8 (32%)	5 (14%)	1 (11%)	.06
	Being too tired for everyday activities	8 (32%)	6 (17%)	1 (11%)	.24
	Not having enough time	3 (13%)	0	1 (11%)	.11

Data are presented as mean ± SD or N (%)

Our study contributes to the literature by examining resilience among Black and White postpartum individuals and identifying negligible impacts of the severity of neighborhood characteristics such as poverty levels and food deserts on resilience scores, an area not previously reported. In addition, we highlight the adverse impact of being overwhelmed by stress on both agency resilience (confidence in achieving goals) and pathway resilience (confidence in identifying strategies to achieve goals). Overall, pathway scores were significantly lower than agency scores across all neighborhood characteristics and barriers to care. This indicates that postpartum individuals in our population feel confident in their abilities to accomplish goals but less confidence in knowing how to achieve them.

The high rates of maternal mortality in Ohio have created an urgent need for increased interventions and programs aimed at maternal health.[45,46] Our findings suggest that programs should focus on self-reported barriers to care rather than broader neighborhood characteristics. Programs addressing social support and stress reduction should be accessible to all pregnant people, regardless of race, socioeconomic status, or neighborhood context. Prior successful interventions such as SDoH screenings, prenatal counseling, advanced practice nursing involvement, and support groups provide a framework for future efforts. [1,4,47]

Stress is a multifaceted factor, compounded by socioeconomic instability, mental health disorders, and global phenomena such as COVID-19 pandemic and social unrest.[48,49] Although patients and communities must be approached with individualized care, research has shown nonpharmacologic therapy including exercise, meditation, and mindfulness are effective in reducing stress, lowering anxiety levels, and improving overall psychological well-being during pregnancy.[47,50]

Strengths and Limitations

This study is limited by the small sample size which restricts our ability to detect differences in the severity of neighborhood characteristics and barriers to care. The survey was only offered in English, limiting generalizability to non-English-speaking populations. Additionally, certain racial groups in the sample did not reside in neighborhoods with low rates of infant mortality or crime, reflecting the historical impact of redlining. This limits our ability to generalize the effects of the severity of neighborhood characteristics across racial, ethnic, and cultural groups. A key strength of the study is its use of both self-reported and publicly available data, which minimizes bias associated with self-reporting.

Table 3. Resilience Scores by Social Determinants of Health Domains: Economic, Education, and Health care

		Column 1 (low-severity)	Column 2 (high-severity)	P
Economic domain				
	Poverty (% of population living below poverty level)	**≤ 3.7%**	**≥ 3.8%**	
	Resiliency - agency score	27.3 ± 3.7	28.4 ± 2.9	.18
	Resiliency - pathway score	27.0 ± 4.2	26.0 ± 4.2	.15
	Having enough money is a problem	**No**	**Yes**	
	Resiliency - agency score	27.9 ± 3.6	27.1 ± 3.1	.45
	Resiliency - pathway score	27.1 ± 3.9	24.9 ± 4.7	.07
	Having enough to eat is a problem	**No**	**Yes**	
	Resiliency - agency score	27.7 ± 3.5	27.8 ±3.0	.92
	Resiliency - pathway score	27.0 ± 3.8	22.3 ± 5.9	.008
Education domain				
	Highest level of education completed	**> High school**	**≤ High school**	
	Resiliency - agency score	27.2 ± 3.4	28.3 ± 3.5	.22
	Resiliency - pathway score	26.5 ± 3.9	26.8 ± 4.6	.74
Health care domain				
	Type of insurance	**Private**	**Public or self pay**	***P***
	Resiliency - agency score	28.1 ± 3.0	27.5 ± 3.7	.46
	Resiliency - pathway score	27.3 ± 3.9	26.2 ± 4.4	.33
	Trimester when first attended prenatal care	**1st**	**2nd or 3rd**	
	Resiliency - agency score	27.5 ± 3.5	29.8 ± 2.5	.15
	Resiliency - pathway score	26.3 ± 4.1	30.0 ± 3.4	.06
	Have own car	**Yes**	**No**	
	Resiliency - agency score	27.9 ± 3.5	26.9 ± 3.4	.37
	Resiliency - pathway score	26.8 ± 4.1	25.8 ± 4.7	.46
	No prenatal care (percentage of women with no prenatal care in the first trimester of pregnancy)	**≤ 25.0**	**≥ 25.1**	
	Resiliency - agency score	27.1 ± 3.5	28.5 ± 3.3	.09
	Resiliency - pathway score	26.9 ± 4.0	26.3 ± 4.6	.54
	Infant mortality (number of infant deaths per 1000 live births)	**≤ 13.4**	**≥ 13.5**	
	Resiliency - agency score	27.6 ± 3.6	27.9 ± 2.5	.82
	Resiliency - pathway score	27.0 ± 4.1	24.8 ± 4.9	.77
	Getting places is a problem	**No**	**Yes**	
	Resiliency - agency score	27.7 ± 3.5	27.7 ± 3.2	.98
	Resiliency - pathway score	26.9 ± 3.7	24.9 ± 6.0	.14
	Not having enough time to go to the doctor is a problem	**No**	**Yes**	
	Resiliency - agency score	27.6 ± 3.5	29.5 ± 1.9	.30
	Resiliency - pathway score	27.0 ± 3.9	21.5 ± 6.9	.01

Data are presented as mean ± SD

Table 4. Resilience Scores by Social Determinants of Health Domains: Neighborhood/Built Environment and Social/Community Context

		Column 1 (low-severity)	Column 2 (high-severity)	P
Neighborhood/Built environment				
	Number of years in current zip code	**> 2**	**≤ 2**	
	Resiliency - agency score	27.4 ± 3.8	28.0 ± 3.1	.46
	Resiliency - pathway score	26.5 ± 4.4	26.7 ± 4.2	.88
	Crime (crime rate per 1000 residents)	**≤ 33.3**	**≥ 33.4**	
	Resiliency - agency score	26.1 ± 3.5	28.6 ± 3.1	.003
	Resiliency - pathway score	25.8 ± 4.0	27.1 ± 4.3	.22
	Food desert (low-income census tracts where a significant number of residents are > 1 mile from the nearest supermarket)	**No**	**Yes**	
	Resiliency - agency score	27.4 ± 3.6	28.6 ± 2.7	.20
	Resiliency - pathway score	26.5 ± 4.0	26.9 ± 4.8	.76
Social/Community context				
	Living arrangement	**With others**	**Alone**	***P***
	Resiliency - agency score	27.5 ± 3.4	28.3 ± 3.7	.43
	Resiliency - pathway score	26.9 ± 3.9	25.8 ± 5.2	.39
	Relationship with baby's father	**Involved**	**Not involved**	
	Resiliency - agency score	27.7 ± 3.4	27.0 ± 6.2	.72
	Resiliency - pathway score	26.7 ± 4.0	24.0 ± 8.0	.27
	Having family support is a problem	**No**	**Yes**	
	Resiliency - agency score	27.6 ± 3.6	28.4 ± 2.4	.56
	Resiliency - pathway score	26.9 ± 3.8	24.3 ± 6.9	.36
	Having friend support is a problem	**No**	**Yes**	
	Resiliency - agency score	27.7 ± 3.5	28.0 ± 2.7	.82
	Resiliency - pathway score	27.0 ± 3.9	22.7 ± 5.6	.02
	Finding childcare is a problem	**No**	**Yes**	
	Resiliency - agency score	27.8 ± 3.5	27.0 ± 3.6	.45
	Resiliency - Pathway Score	27.2 ± 3.7	23.9 ± 5.4	.02
	Being overwhelmed by stress is a problem	**No**	**Yes**	
	Resiliency - Agency Score	28.9 ± 2.7	26.7 ± 3.7	.005
	Resiliency - Pathway Score	27.9 ± 3.5	25.6 ± 4.5	.02
	Feeling too tired for everyday activities is a problem	**No**	**Yes**	
	Resiliency - agency score	27.9 ± 3.5	27.3 ± 3.3	.52
	Resiliency - pathway score	27.2 ± 3.9	24.9 ± 5.0	.06

Data are presented as mean ± SD

It is also important to note that data were collected prior to the COVID-19 pandemic. The pandemic and its aftermath have exacerbated many SDoH including financial instability, food insecurity, mental health stressors, and access to health care. The disruptions may have amplified barriers to care and further impacted postpartum resilience which are not reflected in this study. Further research should examine whether the relationships observed in this study persist or have shifted in the post-pandemic context. Further research is also needed to explore factors influencing resilience and SDoH among pregnant people in our region. Identifying these factors will enable targeted interventions and resources to improve women's confidence in knowing how to achieve their goals, as indicated by pathway resilience scores.

PUBLIC HEALTH IMPLICATIONS

This study highlights the need for targeted interventions addressing social factors and neighborhood characteristics affecting pregnant individuals in Ohio and the United States. Persistent racial and socioeconomic disparities in maternal and neonatal morbidity demand urgent action to implement programs that enhance resilience, reduce stress, and strengthen social support, particularly in underserved communities.

Our findings suggest shifting the focus from abstract neighborhood metrics to tangible, self-reported barriers directly affecting resilience and health outcomes. Programs must address structural and individual challenges that hinder the ability to take actionable steps toward achieving goals. Confidence in abilities (agency resilience) is insufficient without clear strategies to navigate systemic barriers (pathway resilience).

Ohio's high maternal mortality rates signal a public health crisis requiring community-based solutions. Interventions such as SDoH screenings, prenatal counseling, peer support networks, and stress management programs can effectively address these challenges. Addressing systemic racism, food insecurity, and health care access is essential for sustainable change. Equity-focused maternal health strategies can transform outcomes for individuals, families, and communities and serve as a nationwide model for reducing health disparities.

CONFLICTS OF INTEREST

The authors have no conflicts of interest or disclosures to declare.

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AUTHOR CONTRIBUTION

Katie M. Whitehead, Araam E. Abboud, Laura A. Bute: formal analysis, visualization, writing-original draft, writing-review and editing. Katherine E. Wilcher: formal analysis, data curation, visualization, writing-original draft, writing-review and editing. David N. Dhanraj: investigation, formal analysis, writing-review and editing. G. Theodore Talbot: conceptualization, methodological development, data collection, investigation, supervision, writing-review and editing. Rose A. Maxwell: conceptualization, methodological development, data collection, formal analysis, investigation, data curation, project administration, supervision, writing-original draft, writing-review and editing

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RESEARCH ARTICLE

Barriers and Facilitators to Naloxone Uptake in Ohio: Implications for Community-Driven Overdose Reduction Interventions

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ABSTRACT

Background: Our study aimed to identify barriers and facilitators to opioid overdose reversal uptake to inform community-driven interventions.

Methods: We conducted in-depth interviews and focus group discussions with community members and key stakeholders in Central Ohio. We used qualitative thematic analysis to identify barriers and facilitators to naloxone uptake in a community setting. We classified barriers and facilitators using the organizational, community, and societal levels of the socio-ecological model.

Results: Forty-seven Central Ohio residents participated in 5 focus group discussions and 15 in-depth interviews. Community members (n=23), harm reduction service providers (n=4), and religious organizational staff (n=5) participated in focus group discussions. We conducted in-depth interviews with law enforcement officers (n=3), pharmacists (n=2), and people who use opioids (n=10). Access to naloxone and misinformation emerged as organizational barriers while safe spaces for people who use opioids emerged as a facilitator. We identified naloxone misinformation and substance use stigma as community barriers. Perspectives on collective responsibility to administer naloxone was identified as both a barrier and facilitator. Poor communication of naloxone laws was a prevalent societal barrier to naloxone uptake.

Conclusion: Community-based interventions that develop collaborations among local organizations to provide naloxone information, training, and distribution may address prominent barriers to naloxone uptake and reduce the current burden of law enforcement to respond to overdoses. Future interventions should also dispel naloxone misinformation, substance use stigma, and confusion about the legal consequences of administering naloxone.

Keywords: Substance use; Opioid; Naloxone; Injection drug use; Overdose, Community intervention

INTRODUCTION

The growing mixture of fentanyl with heroin and other illicit drugs has contributed to a 1000% increase in the age-adjusted synthetic opioid-involved overdose rate in the United States.[1] The current state of the opioid overdose epidemic will require multilevel solutions to address contributing factors such as the changing drug supply, social distress, and socioeconomic inequalities.[2] Solutions include community-based public health interventions such as access to medications for opioid use disorders, syringe services programs (SSP), and naloxone distribution campaigns.[3]

Naloxone is an easy-to-use and safe opioid receptor antagonist that quickly reverses or blocks the effects of opioids.[4,5] The increasing potency of fentanyl and rising overdose rates exacerbate the need for the availability, accessibility, and community uptake of naloxone.[6,7] When available and accessible, naloxone considerably reduces the number of fatal opioid overdoses in

communities.[8,9] Community naloxone distribution programs are one widespread and effective method to prevent fatal overdoses among people who use opioids (PWUO).[10] Family members, friends, coworkers, and bystanders can safely administer naloxone to someone experiencing an opioid overdose. Despite the ease and safety of using naloxone, community uptake of naloxone remains a barrier to reducing opioid-related harms.

Similar to trends in the United States, the widespread availability of heroin and fentanyl has led to dramatic rates of accidental opioid overdose deaths in Ohio.[11] Naloxone is accessible to Ohioans in pharmacies without the need for a prescription, allowing for increased access to the life-saving properties for those at risk for overdose.[12] Under Ohio law, family members, friends, or other individuals who, in good faith, administer naloxone to an individual who is experiencing or at risk of experiencing an opioid-related overdose are not subject to criminal prosecution.[13] However, stigma, lack of awareness of life-saving properties, and lack of training in administering naloxone are widely prevalent, resulting in low uptake of naloxone.[14]

Our objective was to conduct a qualitative analysis to (1) describe in-depth experiences of opioid overdose and reversal among PWUO and key stakeholders in Central Ohio and (2) identify structural and social level barriers, facilitators, and attitudes toward opioid overdose reversal in Central Ohio.

METHODS

Study Design

The current study provides findings of the Needed Opioid Harm Reduction Messaging (NoHaRM) project, which aims to develop a structural and social network-based opioid overdose reversal campaign within Central Ohio. We used qualitative thematic analysis to identify perceptions of naloxone and perceived barriers to its use in a community setting using interview and focus group discussion text from the NoHaRM project. All participants provided written, informed consent before the in-depth interviews and focus group discussions. The Ohio State University institutional review board approved this study.

Data Collection

We recruited local community members and key informants in Central Ohio for focus group discussions and in-depth interviews through convenience sampling at local community organizations, flyers, and ResearchMatch. Eligible participants were age 18 years or older and resided in Central Ohio, with PWUO qualifying if they had used heroin or other opioids within the past 30 days. Key informants included pharmacists, law enforcement officials, religious service organizations, and substance use service providers who regularly engage with PWUO. Recruitment involved interested individuals contacting study staff or being invited via email, followed by an eligibility assessment and scheduling. Key stakeholder groups, including religiously affiliated community center volunteers, organizational staff, and substance use service providers, participated in focus group discussions, while pharmacists and law enforcement officials were recruited for in-depth interviews, allowing us to refine and confirm focus group data. Qualitative interview guides were tailored to community members, substance use service providers, PWUO, and law enforcement officials using survey items from the Ohio Opioid Project study (Implementing a Community-Based Response to the Opioid Epidemic in Rural Ohio, UG3/UH3DA044822), a literature review, and questions crafted by the study team. The guides covered the following topics: perceptions of drug use in local communities, knowledge of naloxone, local drug use and naloxone laws, and opportunities and challenges to addressing the opioid epidemic in Franklin County, Ohio. See Appendix for in-depth interview and focus group discussion guides. Trained study staff conducted focus group discussions and in-depth interview sessions. An additional study staff member was present in each focus group discussion to take field notes. All in-depth interviews and focus group discussions were audio-recorded and transcribed verbatim.

Qualitative Analysis

NVivo 12 was used to code transcripts. A “flexible coding” iterative process was used to code the data.[15] First, 2 study team members who have expertise in qualitative research and public health needs for PWUO read and reread the transcripts and field notes and applied index codes to the text. Respondent-level and cross-case memos were created as the coders began to draft hypothesized relationships between the index codes. Next, using the index for data reduction, a priori and emergent analytic codes were applied to focused sections of the transcripts. This step prioritized the reliability and validity of the coding. Finally, the reliability and validity of our coding results were confirmed by reviewing and comparing excerpts across analytic codes. The broader study team engaged with the data by reviewing coded excerpts, discussing emerging themes, and refining analytic codes to ensure rigor and validity in the findings.

Socio-ecological Model

Because multilevel factors synergistically impact naloxone uptake, we examined how each factor acted alone or in tandem to influence behavior using a socio-ecological model.[16,17] Socio-ecological models allow for exploring a range of protective and risk factors that contribute to complex circumstances impacting health.[18] The original socio-ecological model suggested that health outcomes are determined by 5 nested levels of factors that interact within an individual's social environment, influencing their behavior: intrapersonal factors (ie, characteristics of the individual), interpersonal factors (ie, social networks), institutional factors (ie, social institutions and organizations with formal and informal rules), community factors (ie, relationships among organizations and institutions), and public policy (ie, laws and policies).[16,17] This approach sustains prevention efforts over time and supports population-level impact. The socio-ecological model has been utilized, modified, and applied within various public health promotion

contexts, including contextualizing the opioid crisis,[19-21] and is a practical approach for assessing the multifaceted barriers and facilitators of naloxone use to inform the development of evidence-based community interventions.

In our analysis, we focused on the 3 broadest levels of the socio-ecological model: (1) public policy, (2) community factors, and (3) organizational factors. We restricted our analyses to these levels because the purpose of the NoHaRM project was to develop a structural and social network-based opioid overdose reversal campaign within Central Ohio. Therefore, our analysis of the barriers and facilitators to naloxone uptake at the broadest levels may best inform this campaign and community interventions in settings outside of Central Ohio.

RESULTS

Participant Characteristics

A total of 47 Central Ohio residents participated in 5 focus group discussions and 15 in-depth interviews between February 2019 and October 2019. Community members (n=23), religious organizational staff (n=5), and harm reduction service providers (n=4) participated in focus group discussions ranging in size from 4-10 participants. In-depth interviews were conducted with law enforcement officers (n=3), pharmacists (n=2), and PWUO (n=10). Most participants were recruited from community outreach (74%), followed by email invitations (17%) and ResearchMatch (9%). In-depth interviews ranged from 27 to 83 minutes, with a median duration of 51 minutes. Focus group discussions ranged from 88 to 124 minutes, with a median of 96 minutes. We collected demographic information for 46 participants; missing information applied to 1 community member (Table 1). Half of the participants were female (50%), the median age was 45 years (IQR: 34-58), and most participants were unemployed (57%) and had completed high school (87%).

Socio-ecological Model: Top-Level Barriers and Facilitators to Naloxone Uptake

We identified barriers and facilitators to naloxone uptake that were aligned with the socio-ecological framework[22] derived from the qualitative data analysis. To directly inform community interventions, identified thematic barriers and facilitators were organized by organizational, community, and public policy levels (Figure 1).

Organizational Level

Barriers

Access to naloxone varied among organizations in Franklin County, Ohio, from limited access among harm reduction organizations to a lack of uncertainty of where or how to obtain naloxone among local for-profit, nonprofit, and government organizations.

> Service Provider: *"we wanna provide the most consistent and reliable coverage for as many people as we can. Unfortunately, it's needed in high demand…I think we're going through about 60 kits per day…That's the most frustrating aspect of this job is being a harm reduction and overdose prevention center and not having naloxone on site and folks are coming in begging for it, begging."*

Table 1. Central Ohio NoHaRM Participant Descriptive Statistics, Stratified by Participant Type (N=47)

	Total[a]		Community Members		People who use Opioids		Key Stakeholders[b,c]	
	N	%	N	%	N	%	N	%
Total	47	100%	23	49%	10	21%	14	30%
Gender								
Women	23	50%	14	64%	5	50%	4	29%
Men	23	50%	8	36%	5	50%	10	71%
Age, median (IQR)[d]	45	(34, 58)	50.5	(35, 60)	39.5	(34, 48)	41.5	(33, 56)
Education								
Less than high school	6	13%	3	14%	3	30%	0	0%
Highschool/GED	8	17%	3	14%	4	40%	1	7%
Some college	13	28%	8	36%	2	20%	3	21%
College graduate	19	41%	8	36%	1	10%	10	71%
Employment status								
Employed (full-time)	19	41%	8	36%	0	0%	11	79%
Employed (part-time)	1	2%	0	0%	1	10%	0	0%
Unemployed[e]	26	57%	14	64%	9	90%	3	21%
County of residence								
Franklin	45	98%	22	100%	10	100%	13	93%
Licking	1	2%	0	0%	0	0%	1	7%
Years lived in Franklin County, mean (std)[f]	23.4	20.1	36.3	17.8	9	11.9	13.6	15.1
Years lived in Central Ohio, mean (std)[g,h]	28.4	19.5	37.9	16.8	-	-	14.4	14.8

[a] Missing demographics from 1 community member participant.
[b] Key stakeholders are defined as law enforcement officers (n=2), service providers (n=4), pharmacists (n=2), and religious organizational staff (n=5).
[c] We condensed these categories to protect participant confidentiality.
[d] Missing age for 2 community member participants.
[e] One person wrote 'retired.' This response was categorized as 'unemployed.'
[f] Years lived in Franklin County was missing for 1 community member and 1 key stakeholder
[g] Years lived in Central Ohio was not recorded for people who use opioids.
[h] Years lived in Central Ohio was missing for 1 community member

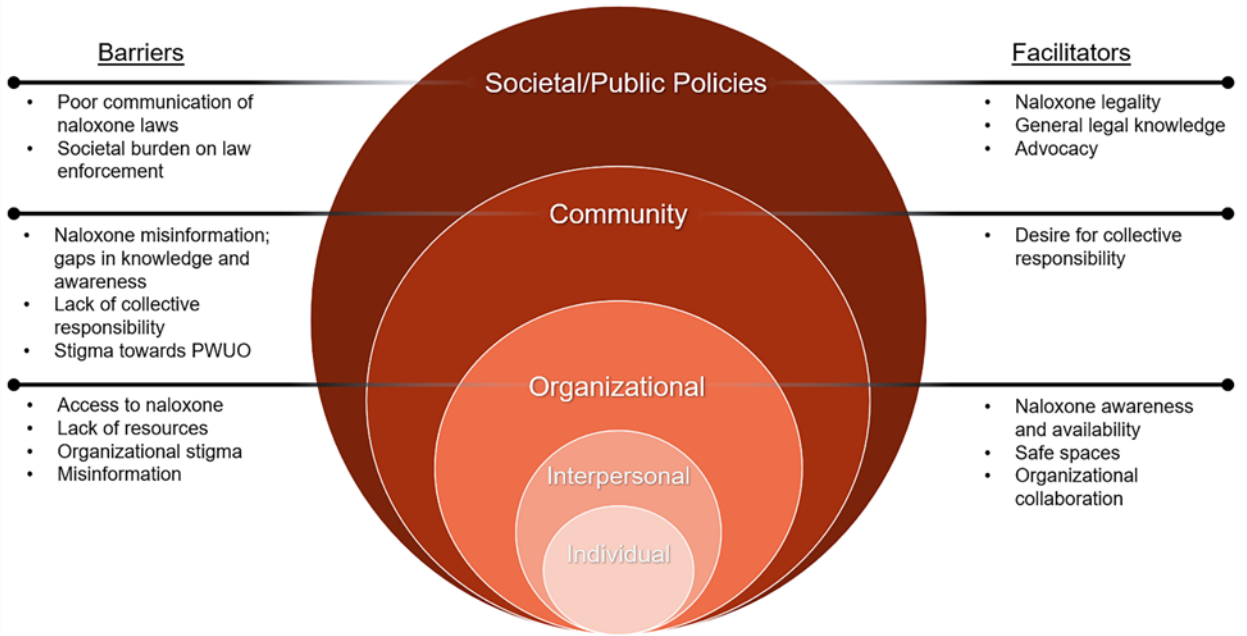

Figure 1. Adapted Socio-ecological Model with Thematic Top-Level Facilitators and Barriers to Naloxone Uptake in Central Ohio

Organizations' attitudes about naloxone may impact employees' perceptions of safety and willingness to use it. As one community member shared, their place of work discouraged the presence and use of naloxone, though the participant kept naloxone in their home and car in case of an emergency.

> Community Member 1: *"I carry naloxone... I had it for a very short time at work. I was told that we are not allowed to administer it on company time. So, there's education there, right, there's knowledge, that saturation is there, but what can I do with it, right?"*
> Community Member 2: *"So corporation that tells him that if he can't use it on the corporate level—"*
> Community Member 1: *"He has to follow it."*
> Community Member 2: *"Yeah, so how does that attitude play in when you get off the clock?"*

Naloxone misinformation and support for naloxone availability varied among participant groups. Community members and religious service providers had mixed opinions on which organizations should make naloxone available. Although many participants felt morally liable to help someone experiencing an overdose, one church member feared that church members would be legally liable if they failed to reverse an overdose. Beyond liability, community members were concerned about overdosing when assisting a person experiencing an overdose, perpetuating myths that touching fentanyl would lead to an overdose.

> Community Member: *"If you even slightly suspect drug use, that's where [the security officers] stop. You know, they were all trained CPR, AED ... Let the medics get there [and handle it]. We could have the naloxone on hand but ... I had security officers that were making $9 an hour. I'm not gonna trust that [they] put on their personal protective equipment before using the naloxone and that's necessary."*
> Later in the focus group discussion:
> Community Member: *"You need to buy your personal protective equipment. Because you don't want any part of your body coming in contact with [fentanyl], they'd want to be wearing at least the gloves ... I would make sure I had a piece of plastic to throw over the person and have my gloves on to at least give them the naloxone."*
> Interviewer: *"What does using the gloves and plastic help prevent?"*
> Community Member: *"Your skin coming in contact with any of the fentanyl that might be on the person ... And from what I believe, is that if there's fentanyl, they could be sweating it out, right?"*

Among law enforcement officials during interviews in 2019, naloxone was available through the Columbus Police Department. Before providing consistent, department-wide access to naloxone, the Columbus Police Department launched a pilot program that provided naloxone to officers who used it to prevent nearly 60 fatal overdoses.[23,24] In 2019, it was unclear from interviews if any officers were required or encouraged to carry naloxone, and no information about departmental naloxone policies was available at the time of interview.

> Interviewer: *"Is [naloxone] voluntary for officers to carry?"*
> Law Enforcement Official: *"I think it is still somewhat voluntary. But I think I would say probably two-thirds of all the officers on every precinct, which each zone has several precincts within the zone."*

Interviewer: *"Would you say it's a norm to have it, or is it still kind of a new thing?"*

Law Enforcement Official: *"No, I don't think at this point I would say they consider that part of their bag of tools. Just like a flashlight and a taser, whatever they're carrying to use in their job."*

Facilitators

Mandatory job training provided most law enforcement officials, pharmacists, and service provider participants with knowledge about naloxone and its purpose. Community members perceived organizations that are receptive to naloxone education and non-stigmatizing substance use discussions as beneficial. Several community members expressed interest in their employers having naloxone on hand and advocated for naloxone to be publicly available at local businesses.

Religious organizations emerged in our interviews as a safe and stigma-free environment, as several staff members are trained in administering naloxone and have it on hand to respond to overdoses aptly. Safe spaces for PWUO also include an SSP and hospitals and clinics with nonstigmatizing staff.

PWUO: *"[The SSP] was wonderful ... I got to learn how to use naloxone for the first time, ...It was just a good feeling to know that there's people that care enough about people's well-being."*

Community Level

Barriers

Accessibility to naloxone (eg, not knowing where to obtain naloxone) within the community was an issue for several participants.

Religious Organizational Staff: *"I think I saw advertised on a news program on TV as supposedly available in drug stores. Now, I don't know if that's true or not."*

Participants also expressed a lack of knowledge about administering naloxone in the community, which led to fear of misuse, misinformation, and possible legal ramifications.

Community Member: *"...that's why I probably never would carry naloxone. I would be very fearful. I know that the city of Columbus was sued for not giving enough [naloxone] to someone who fatally overdosed. Because they say they gave 3, but they probably needed 4 or 5 doses."*

Community Member: "*If the average person doesn't know how it works, then they may say what is it? Am I giving them too much, I'm not giving them enough? ... I'm not even sure in Ohio, I mean, is there a Good Samaritan law in place?"*

Community members' comfort with administering naloxone varied by relationship type and the setting where an overdose takes place. Greater willingness was expressed for assisting close social contacts such as family members and less so with strangers. Self-efficacy was lower when discussing the possibility of administering naloxone in settings where the respondent lacked authority.

Community Member: *"I'm not sure that I'd wanna involve myself in a case of a stranger. If it were my brother, different situation."*

Religious Organizational Staff: *"If I saw someone drop here (at my organization) I would know what to do, but if I were at the grocery store, or pharmacy, I wouldn't know. I would assume the pharmacist would have it (naloxone)."*

Community substance use related stigma perpetuated stigma against naloxone. Several participants discussed a general sentiment about drug use (and subsequent overdose) being a choice. Perceived mental weakness and lack of willpower to curtail opioid use among PWUO diminished the willingness of community members to assist. These stigmatizing beliefs were often associated with the low perceived willingness to carry and administer naloxone. Participants who noted this stigma believed the community would be more conflicted about intervening for an overdose than other medical emergencies.

Pharmacist: *"But you don't see that with CPR. People are freely willing to administer CPR and understand there's no consequence. Because there's nothing worse than death…you'll see that they'll jump to somebody's aid if they're choking. If they're having a heart attack they'll help him. But this is totally different. I think too many people feel like this (opioid use/overdose) is a choice*."

Participants discussed carrying and administering naloxone in such a way that demonstrated a lack of a sense of collective responsibility for intervening in opioid overdoses. When asked, "Who should carry naloxone?" few participants extended this responsibility to the general community. Participants believed many people subscribe to an "it's not my problem" detachment mentality. First responders, health care workers, and others viewed as "authoritative figures" were often cited as most appropriate to assist by all participant types.

Religious Organizational Staff: "*Well, it's almost like it needs to be the authoritative figure. Whether that's in your house, your father or your mother, or at work. If it's someone who people feel has the authority and the knowledge and will make a good decision on when it's needed*."

Facilitators

Although most participants were reluctant to administer naloxone broadly, some pharmacists, law enforcement officials, and PWUO believed everyone should collectively share this responsibility. This position may reflect the community needs best understood by those closest to the epidemic.

Service Provider: *"In my dream world [naloxone] would be as fundamental in a first aid kit as band-aids. Cuz there's no reason not to have it. I mean, people carry Epi-Pens, it should follow the same principle. And especially if someone was using themselves, having it on them, even though they wouldn't be able to administer it themselves, just knowing that was available to anyone who came upon them in an unfortunate circumstance would be highly advantageous."*

Law Enforcement Official: *"Everyone [should carry naloxone]. You never know where you're gonna run into an overdose."*

Societal and Policy Level

Barriers

The most common societal or policy-level barrier was the recognition that law enforcement may not be sufficient for responding to overdoses and naloxone administration. Community members and PWUO expressed concerns that involving law enforcement may lead to legal repercussions or jail rather than medical services and transport.

Community member: *"A lot of people are afraid they're going to go to jail and be criminally charged and a lot of people that do drugs are in the system already. So, they fear that if [law enforcement or emergency medical services] come and they have to rescue me they're gonna throw me in the back of the cop car and come up with any old reason as to why I'm getting arrested."*

Furthermore, law enforcement felt overburdened by the increasing need for overdose responses. Many felt inadequately trained to provide linkages to services for people who overdose.

Law Enforcement Official: *"I really don't, I mean, I think too much is already put on police agencies in this country. I mean, we're expected to be social workers, counselors. We already do way too many things that are not what police officers were created to do in the first place. I mean, at the end of the day, the main job of a police officer, really, is just to enforce the laws of a city or state or a town that they are sworn to uphold and protect. But over the last 50 years, it feels like continuously more has put upon police departments to be responsible for. Which I also think is one reason why with certain segments of the population, the relationship is so bad."*

Community members felt they lacked formal communication channels for common law and policy updates, often resulting in limited knowledge of legal rights and protections related to naloxone administration. Community members felt the Good Samaritan law was confusing and were unaware of what protections would be provided to them if they reported an overdose. As a result, PWUO and community members discussed reluctance to report overdoses due to fear of arrest for drug possession.

Other societal barriers impacting naloxone use among the general public include knowledge gaps among community members in understanding the Good Samaritan law and other naloxone and drug possession related policies, inadequate access to drug treatment and health care services, and pervasive poverty and income inequality that limits engagement in treatment services. For example, even if participants were able to access naloxone at pharmacies or other community locations, cost remained a barrier.

Pharmacist: *"...we're trying to currently look for a way to get naloxone to patients in an affordable way because right now it's not available on a slide program because of the expense of the medication."*

Facilitators

Law enforcement and pharmacists discussed processes for receiving common law and policy updates. Law enforcement officials felt they knew laws regarding obtaining, carrying, and administering naloxone. They noted the professional requirement of reviewing legal updates and attending several monthly training sessions.

Pharmacists discussed receiving monthly notifications from the Ohio Board of Pharmacy about laws and policies related to drug use in Ohio. They also grasped the overall concept of Ohio's Good Samaritan Law but were unaware of the specific details and thought the laws should be advertised to increase awareness.

DISCUSSION

Our findings demonstrate key barriers and facilitators to opioid overdose reversal in Central Ohio. Many felt law enforcement had become the first responders to overdose, resulting in law enforcement burnout and acknowledgment of limited social service training. People who use opioids and community members also reported hesitations in involving law enforcement or providing emergency medical assistance due to previous negative interactions or fear of criminal charges. Additional barriers to naloxone use include naloxone misinformation and general drug use related stigma. Despite these barriers, some felt a shared collective responsibility to reduce overdose deaths by carrying and using naloxone. Several community organizations, including religious organizations, were noted as possible avenues for providing safe spaces for PWUO and fostering naloxone awareness and training. Within Ohio, several policies exist that could encourage naloxone use and legally protect those who administer naloxone; however, awareness and understanding of policies were limited among community members, pharmacists, and law enforcement.

Relying on law enforcement for overdose first response and naloxone administration may be inadequate for reaching PWUO. Participants in our study noted law enforcement officials burnout and societal burden, which aligns with previous studies. A study among law enforcement officials in British Columbia, Canada, identified a complete systematic failure of law enforcement and the criminal justice system to address the needs of people who use drugs.[25] Punitive legal systems lead to suboptimal engagement in drug use treatment and other drug related care, often due to stigma and discrimination from those involved in these systems. Despite law enforcement officials being a frequent point of contact for overdoses, law enforcement officials within our study and others noted their limited capacity to provide sufficient support for PWUO, such as social services and linkage to care. Future studies are needed to explore the positioning and role of law enforcement in delivering overdose response and ongoing care for PWUO in Ohio. Given the overwhelming burden placed on law enforcement and emergency responders, the presence of safe injection sites

with staff trained to administer naloxone could alleviate ambulance calls and reduce fatal overdose rates.[26-28]

A knowledge gap regarding use and safety predominantly drives naloxone misinformation within organizations and among community members. Among our sample, community members and law enforcement officials expressed concerns that having naloxone readily available could encourage more substance use, likely leading to more overdoses. This misinformation drives perceptions of which organizations should provide naloxone for employees within retail and work environments and the general public. Despite the common notion of naloxone availability leading to more overdoses, research indicates that widespread naloxone among PWUO does not increase opioid use.[29] Furthermore, many feared needing proper protective equipment for administering naloxone due to scientifically unfounded fear of contact exposure, particularly from fentanyl. Misinformation on the scientifically unsupported consequences of tactile and respiratory contact with fentanyl has been spread across mainstream and social media.[30] Our findings demonstrate a need for interventions to specifically address widespread naloxone misinformation and compassionate awareness of opioid overdose.

The lack of awareness and understanding of Good Samaritan laws among community members presents a significant public health challenge, potentially deterring individuals from seeking emergency assistance during overdoses. Many participants expressed confusion and uncertainty regarding the legal protections afforded to them if they reported an overdose, contributing to a reluctance to call for help due to fear of arrest.[31-33] This highlights a broader issue of limited formal communication channels for disseminating updates on laws and policies related to naloxone and drug possession. Misconceptions about Good Samaritan laws can undermine their effectiveness, reducing the likelihood that people will intervene in overdose situations.[8,34] While law enforcement officials and pharmacists reported receiving regular policy updates and training, gaps in community-level awareness remain, suggesting that current educational efforts are insufficient. Addressing these knowledge barriers through widespread public education campaigns, clearer messaging on legal protections, and accessible community outreach efforts could help increase naloxone use, reduce overdose fatalities, and strengthen public trust in harm reduction policies.

Within our sample, many recognized the collective responsibility to reduce overdose deaths among PWUO, paving the way for community-driven approaches for naloxone information, training, and distribution. Naloxone community-based interventions can build on shared values and social practices to overcome barriers to widespread naloxone availability. Based on our sample, community organizations, including religious organizations, could be ideal settings for naloxone information, training, and distribution to supplement SSP. Naloxone community-based interventions have effectively improved knowledge and training and have the strong potential to reduce opioid overdose deaths effectively.[35] However, given the heterogeneity of these types of interventions, evidence is needed on the intervention quality and fidelity to guide further scale-up. Furthermore, increasing naloxone accessibility should be paired with other effective community-based interventions, such as increasing initiation to medications for opioid use disorders and improving retention of these medications, to reduce opioid overdoses in Ohio.[36]

Given the qualitative nature of this study, we recruited a nonrandom sample of PWUO, community members, pharmacists, and law enforcement officials to participate in interviews or focus groups, which may not be fully representative of others in Central Ohio. A sample of 15 PWUO and 15 key informants was deemed an appropriate sample size for in-depth interviews due to the exploratory nature of this research and the anticipated availability of respondents. Although 10 PWUO was a large enough sample for no new themes to emerge, the key informant sample was insufficient to achieve data saturation. Therefore, voices are missing, and the validity of the results may be limited. Another limitation of this study is the implications of focus group dynamics for some participants.[37] Focus groups can result in strongly opinionated individuals guiding the conversation and ultimately shaping the group narrative, especially with sensitive topics such as overdose deaths. These dynamics can lead to individuals saying what is socially accepted by the emerging group narrative and not wanting to share deviant opinions, which may have discouraged candid discussion of more barriers to naloxone. Nonetheless, interviewers and facilitators were trained in nonjudgmental techniques and attempted to encourage participation from all participants.

PUBLIC HEALTH IMPLICATIONS

Despite the life-saving properties of naloxone, several barriers must be addressed at the societal, community, and organizational levels to increase widespread use in Central Ohio. Community-driven approaches that capitalize on amplifying the collective responsibility shared by the community, organizations, and law enforcement on naloxone administration, legal protections, and stigma reduction will be essential in effectively reducing opioid-related overdose in Ohio and similar settings with high overdose death rates.

CONFLICTS OF INTEREST

The authors have no competing interests to declare.

AUTHOR CONTRIBUTION

Angela Estadt, Kathryn Lancaster, and JaNelle Ricks contributed to writing—original draft, reviewing, and editing. Sabrina Sanchez contributed to writing – reviewing, and editing. Angela Estadt and Sabrina Sanchez contributed to data collection and analysis. Angela Estadt prepared Figure 1. JaNelle Ricks and Kathryn Lancaster were involved in conceptualization, methodology, supervision, and funding acquisition. All authors critically reviewed and approved the final manuscript.

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APPENDIX In-Depth Interview Guides and Focus Group Discussion Guides

A. In-Depth Interview Guide for People Who Use Opioids

Interview guide objectives: This interview guide is for people who use opioids (PWUO). The goal of the interview guide is to gain a better understanding of the context of opioid and other drug use, injection drug use, service utilization, and barriers to services in drug-using or PWUO populations.
Note for interviewers: Probes for each question are flexible. We would like to use similar probes across all sites, but you can adjust the wording, order, etc as you see fit – they are a guideline for topics to explore.
Intro: Thank you so much for talking with me today. As you know, we're interested in learning more about drug use in [County name], so I have some questions for you. Everything you tell me will be kept confidential and we will not share your name with anyone besides study staff. Stop me at any time if you have any questions for me as we go through, if anything is unclear, or if you would prefer to skip a question.
We would like to hear about your experience with opioids and other drugs, so that we can help develop programs and policies that may make services that you actually want to use more available to you. Your participation may help to make things better for people in your situation, and those who come along after you – so we appreciate the time that you are taking to talk to us.
Any questions before we begin?
Background/Intro

1. I would like to start by getting to know you a little better.
   Probes:
   a. Where did you grow up? [If not from the area]: How long have you been in this area?
   b. Tell me about your family and friends.
      i. Who do you get help or advice from, when you need it?
   c. Tell me about someone who has had a positive influence in your life?
   d. What community organizations are you involved in? What activities do you participate in?
      i. Are you involved with a local church?
      ii. Do you attend Narcotics Anonymous meetings?

Drug Use – History and Current Use
Now I'd like to ask you some questions about drug use.

2. Tell me about any experiences you have had with using an opioid – like a pain pill or heroin – to get high? If yes: Probes:
   a. How old were you, the first time?
   b. Who were you with? Where were you? Where did you get the drugs?
   c. How has your opioid use changed since you first started?
      i. How regularly do you use prescription opioids now? What do you use? Where do you get them from?
      ii. How regularly do you use heroin now? Where do you get the heroin?
3. What drugs are you injecting currently? [Note: probes a-e below are for each substance mentioned]:
   a. Tell me about the most recent time that you used it. How much did you use?
   b. Who else was there? Where were you? Is this your ideal place? Why did you use drugs there?
   c. Whose syringe did you use? [If not their own]: Who used it before you did? Who used it after you did? What type of syringe was it (eg, insulin, other than insulin, removable needle?) [If purchased]: How much did it cost?
   d. What did you do, if anything, to protect yourself from some of the negative consequences of using drugs? (eg, things like HIV, HCV, overdose, or abscesses?)
      i. How did you clean your skin? How did you stop the bleeding after you injected? Does this vary by the type of drug you're using, eg, black tar heroin, pills, etc?
   e. How has your use of this drug changed over time?
   f. How often are you rushed when you are injecting? What are the typical ways that you get ready to inject, stop injection site bleeding and clean-up after you inject?
4. You mentioned that you inject [list all substances mentioned from question 2].
   a. [If haven't mentioned fentanyl]: Have you ever used any drugs containing fentanyl? Did you realize before or after you took the drug that it contained fentanyl? Were you seeking a drug that contained fentanyl, or were you unaware? How did you know/how were you aware that it had fentanyl?
   b. Where did you get it from?
   c. How are the drug preparations different across the drugs (eg, pills, heroin, fentanyl, methamphetamine, cocaine, etc.)?
   d. What type of equipment do you use for different drugs? Is the amount of water you add different?
   e. Do you need to inject more or less frequently depending on the drug? Can you explain?
   f. Can you tell me any instances when you have injected pills? Can you describe the type of pill? How does the type of processes you use differ from powder?

Overdose and Naloxone/Narcan
Now I'd like to ask you some questions about overdose.

5. How do you define an overdose? How do you determine if someone is overdosing or just high?
   a. Under what circumstances do you think you're most likely to overdose? Using which drugs?
6. Tell me about your most significant experience with someone else overdosing? [If unclear: In other words, the experience that affected you the most?]
   a. Where were you?
   b. What did people do? What did you do? Was EMS or 911 called?
   c. What drug(s) were involved?
7. Now I'll ask about your experience with overdosing, which includes if you passed out, turned blue, or stopped breathing from using drugs. Have you ever overdosed? [If yes]: Tell me about the most recent time that you overdosed.
   a. What happened?
   b. Where were you?
   c. Were you alone or with others? Who?
   d. What did people do? Was EMS or 911 called?
   e. Were you taken to a hospital? Are people concerned about being arrested if 911 is called for an ambulance?
   f. What drug(s) were you using?
8. How confident do you feel in your ability to respond to an overdose?
9. What do you know about Narcan?

a. How is naloxone administered?
b. Tell me about a time you have used naloxone/Narcan or seen someone use naloxone/Narcan. How did you administer it?

10. What do you know about obtaining/accessing/buying naloxone/Narcan?
    a. Do you know where you can access naloxone/Narcan for free?
    b. Experience obtaining naloxone/Narcan?
    c. Do you currently have naloxone/Narcan with you or at home? If you wanted to get naloxone/Narcan, do you know how to get it?
11. Are you trained in using naloxone?
    a. If not, do you have interest in being trained
12. If you have a naloxone kit, where do you keep it?
    a. If don't have a kit, where would you keep it?
13. Who do you think should carry naloxone?
    a. What concerns would you have about carrying naloxone?
        i. How practical would it be to carry it?
    b. What would make you more likely to carry naloxone?
14. Who do you know that carries naloxone?
    a. Should naloxone be provided to friends and family members? Why or why not?
    b. Should naloxone be provided to suppliers?
15. Would you recommend naloxone to others?
16. How confident are you that naloxone would work if you overdosed?
17. Tell me what you know about the state's laws related to getting or using naloxone (Narcan)? About calling 911 if someone overdoses?

Interaction with Law Enforcement/Laws and Policies

Now I'd like to ask you some questions about your interactions with police (local police, sheriff deputies, state police, DEA).

18. Tell me about the last time that the police stopped you.
    a. What were the reasons that they stopped you? Where were you? What were you doing?
    b. How did they treat you? What happened in the end?
    c. Tell me about any experiences you have had with being beaten by the police?
        i. What happened?
    d. Tell me about any times you called the police for help? If so: Tell me about the last time you called the police for help. How did they respond? What were the reasons that you called them?
        i. How did they treat you? What happened in the end?
        ii. How typical is this of the police, sheriffs, or other law enforcement?
    e. What do you think about the police, generally?
    f. Tell me about any experiences you have had when you needed the police, but didn't call them? What are the reasons that you didn't call?
19. Have the police ever stopped you for drug use?
    a. Where were you?
    b. How did they treat you? What happened in the end?

Sometimes, state laws and policies just aren't communicated well to people. I'd like to ask you a few questions about state laws and policies related to drug use.

20. Tell me what you know about the state's laws related to possession of drug paraphernalia?

Services/Health Care

Now I'd like to talk to you about your experiences with health providers and other community services. To start, I'd like to ask about how you get health care and what your experience has been.

21. Do you have health insurance?
    a. [If yes]: What kind?
    b. [If no]: What do you do if you're sick or injured?
22. How do you decide when it's time to go to a health care provider?
23. Where do you usually go when you need health care (hint: private doctor, clinic, ER, etc.)?
    a. How do you feel about this place? How do you feel about the staff members who work in the health care office? How do you feel about your health care provider?
24. Tell me about your most recent interaction with any doctor or other health care provider.
    a. When did you go? What led you to see a doctor or health care provider?
    b. How did you get there?
    c. How did you feel about your experience in the waiting area?
    d. How did you feel about the people you interacted with before you saw your provider?
    e. How did you feel about the provider? (hint: comfort level, communication style)
    f. How, if at all, did the topic of drug use come up?
        i. [If drug use was discussed]: How did the conversation go? What topics did you discuss? Did they discuss the possibility of substance use treatment? What did you like about the conversation? What didn't you like about it?
        ii. [If drug use was not discussed]: Would you have wanted to talk with your provider about drugs? What kept you from discussing it? What would you have wanted to say or ask?
    g. Is this typically where you go to seek care? [If yes, move on. If no]: What are the reasons you chose to go this place versus your normal place? How does this differ from your normal place?
25. Have you ever decided that you needed care, but didn't go? Tell me about the reasons you didn't go.
    a. Insurance?
    b. Transportation?
    c. Could not make an appointment?
    d. Afraid/concerned about how the doctor would treat you?
26. Where do you usually get your prescriptions filled?
    a. How do you feel about the pharmacy staff at this place?
    b. Tell me about any other experiences you have had receiving drug-related services. What kind of clinics or providers did you go to?
    c. Tell me about your interest in accessing methadone or buprenorphine treatment in the future.
        i. [If interested]: Why are you interested? Is there anything that might make it easier for you?
        ii. [If not interested]: What makes you feel that way?
27. Tell me about any times you got a needle or syringe from a syringe exchange program? Probes:

   a. Tell me about your experiences getting needles or syringes from a syringe exchange program? This could include you going yourself, or getting them from someone who went to a syringe exchange program.
      i. [If getting from someone else]: Why didn't you go yourself? Awareness/hours/access/concern about how program staff would treat you?
   b. How did you first hear about it?
   c. How often do you use it? How many syringes do you typically turn in and how many can you get?
   d. What do you like about it? Tell me about any challenges to using it? What other services do you think it should offer? How could it be made better?
28. What other services would you be interested in receiving?
   a. What locations would you prefer to go to?
29. We have talked about many things today. I really appreciate your willingness to share your thoughts. Is there anything else that you feel that I should know or that we haven't covered but you feel is important for us to know?

Conclusion: Thank you so much for talking with me today – we really appreciate it. If you have any concerns, please don't hesitate to reach out at the number provided on the consent form!

B. In-Depth Interview Guide for Law Enforcement

Intro: Thank you so much for talking with me today. As you know, we're interested in learning more about your experience with the opioid epidemic in your area, so I have a few questions for you. Once again, everything you tell me will be kept confidential and will not be linked to you in any way. Of course, if you have any questions for me as we go through, if anything is unclear, or if you would prefer to skip a question, please don't hesitate to stop me at any point. Any questions before we begin?

*To keep things consistent, I want to ask first what term you would usually use to describe drug users. For example: "drug users," "drug addicts," "people who inject drugs," "injection drug users," "injectors," etc. That way, I can use that for the rest of the interview.

[Note to interviewer: use whatever language provided in place of "PWUO" throughout the guide.]

Background/Intro

1. What is your position in your organization? Tell me about what you do on a typical day at work.
   a. Tell me about the people you interact with on a typical day at work (coworkers, other organizations, regular people, etc.).
   b. What population/populations do you largely work with? Do you work directly with PWUO?
2. How often do you personally interact in any way with PWUO?
   a. Tell me about your most recent interaction, or tell me about a typical interaction.
   b. Has this changed in the past few years? Can you describe how?
   c. What are some challenges to working with PWUO? Have these changed recently? (gotten worse? better?)
   d. How adequately prepared have you felt for working with PWUO?

Laws/Policies

There are so many different laws and policies that can vary in each different state, when it comes to drug use and possession. Sometimes it's hard even for law enforcement agencies to keep track of this.

3. How do you typically find out about different laws and policies in Ohio?
   a. Do you ever get training on these laws and policies? Tell me more about this.
   b. How do you find out about changes in laws and policies?
4. It would be helpful for us to get more information about some of Ohio's laws. You may or may not be familiar with all of these, and that's totally fine. How familiar are you generally with Ohio's laws on drug use?
   a. Tell me about Ohio's laws on syringe possession?
   b. Tell me about Ohio's laws on syringe distribution?
   c. Tell me about Ohio's Good Samaritan laws?
   d. Tell me about Ohio's naloxone laws?
   e. Tell me about Ohio's laws related to HIV criminalization/conduct while HIV-positive?
5. What do you think about these laws and policies?
   a. Are they helpful or unhelpful?
   b. Do you think you would like to know more about Ohio's laws related to drug use?
   c. Do you think most law enforcement agents have a similar level of understanding of these laws, or not?
   d. Do you think most law enforcement agents have a similar opinion toward these laws and policies, or not?
6. Do you know of other organizations that work with PWUO?
   a. What types of organizations? What services do these organizations provide?
   b. How did you learn about these organizations? Do you work with them, or do you know others who work with them? Do you interact with them in any way? Tell me more about this.
   c. How often do you interact with these groups? Think about the last time you interacted with one of these organizations. Can you tell me about this? What led up to the interaction/what was the nature of the interaction? How did you feel about the interaction? Was it effective/productive? Is that typical?
   d. How do you feel about these organizations? Do you think they are effective or not? In what ways? Are there ways in which you think they could be made more effective?
7. From your experience interacting with PWUO, what do you think are some of the reasons people might start abusing and injecting drugs?
   a. How would you describe the typical person who injects drugs?
   b. What do you think drives people to start misusing drugs?
   c. Where do you think they're getting their drugs from?
8. What do you think about the opioid epidemic overall? What kinds of broader things do you think are driving the epidemic?
   a. What kinds of things in your community do you think have contributed to the increase in drug/opioid abuse?
   b. Are there any other things that you think might be contributing? (eg, local or state policies, economic conditions, etc.)
9. How would you say law enforcement agents have been impacted by the opioid epidemic? How has your typical day changed?
   a. Over what time period have you noticed any changes? The last year? Several years?
   b. What do you think the biggest impact on your work has been?
10. Do you think that PWUO are successfully getting help for drug use in your community?
   a. Do you think that PWUO are getting the treatment or health care services that they need? Why or why not?
   b. What do you think might make it difficult to get treatment? (Is this a problem with availability of services, or a problem with people being able to access the services that are available?)

Narcan

11. What do you know about Narcan/naloxone?
    a. How is naloxone administered?
12. What do you know about obtaining/accessing/buying naloxone?
    a. Do you know where you can access naloxone for free?
    b. Experience obtaining naloxone?
13. If you have a naloxone kit, where do you keep it? (If don't have, where would you keep it?)
    a. Are you trained in using naloxone? If not, do you have interest in being trained?
14. Who do you think should carry naloxone?
    a. What concerns would you have about carrying naloxone?
        i. How practical would it be to carry it?
    b. What would make you more likely to carry naloxone?
15. Who do you know in your personal life who carries naloxone?
    a. Should naloxone be provided to friends and loved ones of PWUO? Why or why not?
    b. Should naloxone be provided to suppliers?
    c. Would you recommend naloxone to others?

Opportunities/Challenges

16. What do you see as the biggest challenges to addressing the epidemic?
    a. What are some challenges to your organization in particular? (eg staffing, resources, time, etc.)
    b. What are some challenges to other organizations?
    c. What do you think needs to be done? What would you like to see/what could be improved? (eg, organizations interconnected, more resources, different policies, etc.)
17. What do you think your organization could realistically do to address the epidemic?
    a. Do you currently have the capacity to expand? Would you and others be willing to expand your services, or is that not realistic?
    b. What is the overall attitude toward handling the epidemic at your organization? How would you describe it?
    c. Do you have any other thoughts about the epidemic, or experiences with PWUO, that you'd like to share with me?

Conclusion: Thank you so much for talking with me today – we really appreciate it. If you have any concerns, please don't hesitate to reach out at the number provided on the consent form!

C. Focus Group Discussion/In-Depth Interview Guide for Service Providers and Pharmacists

Intro: Thank you so much for talking with me today. As you know, we're interested in learning more about your experience with the opioid epidemic in your area, so I have a few questions for you. Once again, everything you tell me will be kept confidential and will not be linked to you in any way. Of course, if you have any questions for me as we go through, if anything is unclear, or if you would prefer to skip a question, please don't hesitate to stop me at any point. Any questions before we begin?

*To keep things consistent, I want to ask first what term you would usually use to describe people who inject drugs. For example: "people who inject drugs," "injection drug users," "injectors," etc. That way, I can use that for the rest of the interview.

[Note to interviewer: use whatever language provided in place of "PWUO" throughout the guide.]

Background/Intro

1. What services do you/your organization provide? Tell me about what you do on a normal day at work.
    a. What population/populations do you largely work with? Do you work directly with PWUO?
2. How often do you personally interact with PWUO?
    a. Tell me about your most recent interaction.
    b. What is it like taking care of people who inject drugs? Has this changed in the past few years? Can you describe how?
    c. How does working with PWUO differ from working with other clients?
3. Do you know of other organizations that work with PWUO?

    [If more than 5 organizations listed]:
    a. What services do these organizations provide?
    b. Of these, which would you consider to be the most important key players?

    [If less than 5 organizations listed]:
    a. Do you work with them, or do you know others who work with them? Do you interact with them in any way? Tell me more about this.
4. From your experience interacting with PWUO, what do you think are some of the reasons people might start abusing and injecting drugs?
    a. How would you describe the typical person who injects drugs?
    b. What do you think drives people to start misusing drugs?
    c. Where do you think they're getting their drugs from?
5. What kinds of things in your community do you think have caused the increase in drug/opioid abuse?
    a. Are there any other things that you think might be contributing? (eg, local or state policies, economic conditions, etc.)
    b. What do people in your community think about the issue, eg how much it occurs, why it is occurring in your community, or what the consequences are? Do you think these perceptions are accurate, or not?
6. Do you think that PWUO are successfully getting help for drug use in your community?
    a. Do you think that PWUO are getting the treatment or health care services that they need? Why or why not?
    b. What do you think might make it difficult to get treatment? (ie, is this a problem with availability of services, or a problem with people being able to access the services that are available?)
7. How would you say your organization has been impacted by the opioid epidemic? How has your typical day changed?
    a. Over what time period have you noticed any changes? The last year? Several years?
    b. How do you think your observations compare with how the opioid epidemic has been seen in the media?
    c. What do you think the biggest impact on your work has been?
8. Has the population of people that you see changed over the past 5 years? If so, how? Probes:
    a. Are they getting older or younger? Are there more men or women?
    b. Do they have health insurance?
9. What do you know about HIV and HCV among PWUO? What do you think your colleagues know?
    a. What might help increase awareness among health care providers?
10. Are you comfortable talking to your opioid-using patients about drug use services?
    a. Would you be comfortable talking about buprenorphine or methadone treatment?

b. Would you be comfortable talking about syringe exchange programs?
c. What other services might you talk about? Why or why not?
d. What makes it difficult to talk about drug use services with your patients? What might make it easier?

Narcan

11. What do you know about Narcan/naloxone?
    a. How is naloxone administered?
12. What do you know about obtaining/accessing/buying naloxone?
    a. Do you know where you can access naloxone for free?
    b. Experience obtaining naloxone?
13. If you have a naloxone kit, where do you keep it? (If don't have, where would you keep it?)
    a. Are you trained in using naloxone? If not, do you have interest in being trained?
14. Who do you think should carry naloxone?
    a. What concerns would you have about carrying naloxone?
        i. How practical would it be to carry it?
    b. What would make you more likely to carry naloxone?
15. Who do you know who carries naloxone?
    a. Should naloxone be provided to friends and loved ones of PWUO? Why or why not?
    b. Should naloxone be provided to suppliers?
    c. Would you recommend naloxone to others?

Laws/Policies/Law Enforcement

There are a lot of different laws and policies about drug use in each different state, and even organizations may not know about all the different laws.

16. How do you find out about laws and policies related to drug use, or changes to laws/policies in Ohio?
    a. What can you tell me about Ohio's laws/policies about drug possession?
        i. About possession of needles or other paraphernalia?
        ii. About Good Samaritan laws related to getting or using naloxone (Narcan)? About calling 911 if someone overdoses?
        iii. Other important drug use laws?
    b. What do you think about these laws and policies? Are they helpful, or unhelpful?
    c. Do you think most other organizations or individuals who interact with PWUO have a similar level of understanding of these laws/policies, or not? How do you think they view these laws similarly or differently?
17. Do you interact with the police in the context of drug use?
    a. How/in what context do you interact with the police?
    b. How does this normally go? Give me an example. (How would you describe these interactions?)
    c. How would you describe the response of the police to drug use and the opioid epidemic?

Opportunities/Challenges

18. What do you see as the biggest challenges to addressing the epidemic?
    a. What are some challenges to your organization in particular? (eg, staffing, resources, time, interactions with other organizations, etc.)
    b. How adequately prepared have you felt for working with PWUO?
    c. What are some challenges to other organizations?
    d. What would you like to see/what could be improved? (eg, organizations interconnected, more resources, etc.)
        i. What local resources are available that you think could play a role?
    e. Are there community members who oppose or might oppose efforts to address these issues? How do you think they will show their opposition?
19. Have you ever not been able to accommodate a drug user? (eg, it was out of your skill area, you didn't have time, etc.)
    a. What was/were the reason(s)?
20. What do you think your organization could realistically do to address the opioid epidemic?
    a. What do you think is needed?
    b. If there were an effort launched to increase services for PWUO, would this be acceptable to your organization? What would be some limitations?
    c. Do you currently have the capacity to expand? Would you and others be willing to expand your services, or is that not realistic?
    d. What is the overall attitude toward handling the epidemic at your organization? How would you describe it?
21. Do you have any other thoughts about the epidemic, or experiences with PWUO, that you'd like to share with me?

Conclusion: Thank you so much for talking with me today – we really appreciate it. If you have any concerns, please don't hesitate to reach out at the number provided on the consent form!

D. Focus Group Discussion Guide for Community Members/Religious Organizational Staff

Intro: Thank you so much for talking with me today. As you know, we're interested in learning more about your experience with the opioid epidemic in your area, so I have a few questions for you. Once again, everything you tell me will be kept confidential and will not be linked to you in any way. Of course, if you have any questions for me as we go through, if anything is unclear, or if you would prefer to skip a question, please don't hesitate to stop me at any point. Any questions before we begin?

Background/Intro

I would like to start by getting to know you a little better.

1. How long have you lived in this area?
2. How has drug use in this area changed while you have lived here?
    a. Tell me about any changes in the number of people using drugs to get high?
    b. Tell me about any changes in what people are using?
    c. Tell me about any changes in the kinds of people who are using?
    d. Tell me about reasons you think these changes have happened?
3. What kinds of things in your community do you think have caused the increase in drug/opioid abuse?
    a. Are there any other things that you think might be contributing? (eg, local or state policies, economic conditions, etc.)
    b. What do people in your community think about the issue, (eg how much it occurs, why it is occurring in your community, or what the consequences are)? Do you think these perceptions are accurate, or not?
4. Do you think that PWUO are successfully getting help for drug use in your community?
    a. Do you think that PWUO are getting the treatment or health care services that they need? Why or why not?

b. What do you think might make it difficult to get treatment? (ie, is this a problem with availability of services, or a problem with people being able to access the services that are available?)

Narcan

5. How confident do you feel in your ability to respond to an overdose?
6. What do you know about Narcan?
   a. How is naloxone administered?
   b. Tell me about a time you have used Narcan or seen someone use Narcan. How did you administer it?
7. What do you know about obtaining/accessing/buying naloxone?
   a. Do you know where you can access naloxone for free?
   b. Experience obtaining naloxone?
   c. Do you currently have Narcan/naloxone with you or at home? If you wanted to get Narcan/naloxone, do you know how to get it?
8. If you have a naloxone kit, where do you keep it? (If don't have, where would you keep it?)
   a. Are you trained in using naloxone? If not, do you have interest in being trained?
9. Who do you think should carry naloxone?
   a. What concerns would people in your community have about carrying naloxone?
      i. How practical would it be to carry it?
   b. What would make them more likely to carry naloxone? You?
10. (If you carry/are trained to use naloxone) Would you recommend others to be trained to use/carry naloxone?
    1. What might prevent people you know from being trained?
11. Who do you know that carries naloxone?
    a. Should naloxone be provided to friends and family members? Why or why not?
    b. Should naloxone be provided to suppliers?
12. What do you see as challenges to using naloxone in your community?
    a. Law enforcement stance on its use?
    b. Religious organization stance on its use?
    c. Availability of naloxone?
    d. Knowledge of naloxone or perceptions about naloxone use?

Laws/Policies

There are a lot of different laws and policies about drug use in each different state, and even organizations may not know about all the different laws.

13. How do you find out about laws and policies related to drug use, or changes to laws/policies in Ohio?
    a. What can you tell me about Ohio's laws/policies about drug possession?
       i. About Good Samaritan laws related to getting or using naloxone (Narcan)?
       ii. About calling 911 if someone overdoses?
    b. What do you think about these laws and policies? Are they helpful, or unhelpful?
    c. Do you think most other people in your community have a similar level of understanding of these laws/policies, or not? How do you think they view these laws similarly or differently?

Opportunities/Challenges

14. What do you see as the biggest challenges to addressing the opioid epidemic in Columbus?
    a. What would you like to see/what could be improved? (eg, organizations interconnected, more resources, etc.)
       i. What local resources are available that you think could play a role?
    b. Are there community members who oppose or might oppose efforts to address these issues? How do you think they will show their opposition?
15. Have you ever not been able to accommodate a drug user? (eg., it was out of your skill area, you didn't have time, etc.)
    a. What was/were the reason(s)?
16. What do you think communities could realistically do to address the opioid epidemic?
    a. What do you think is needed?
    b. What is the overall attitude toward handling the epidemic in your community? How would you describe it?
17. We have talked about many things today. I really appreciate your willingness to share your thoughts. Is there anything else that you feel we should know or that we haven't covered but you think is important for us to know?

Conclusion: Thank you so much for talking with me today – we really appreciate it. If you have any concerns, please don't hesitate to reach out at the number provided on the consent form!

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RESEARCH ARTICLE

The Effects of Hygiene Standards Pre- and Post-COVID-19 Shutdown on Fever and Diarrhea Incidence in a Daycare

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ABSTRACT

Background: One of the most broadly available forms of child care in the United States is a childcare program (CCP). Because of the nature of CCPs, children and their caregivers interact closely within confined spaces, creating opportunities for infectious agent transmission. We hypothesized that a reduction in the room's population density due to requirements related to the COVID-19 outbreak would lead to a reduction in incidence of disease symptom presentation.

Methods: For this observational study, data were collected beginning in January 2018 and lasting until May 2021 from a university-run CCP. Searches of email communications between caregivers and parents were conducted to look for disease exposure notices and phrases related to enteric illness. Zero-inflated Poisson models were used to look for significant influences affecting incidence rates.

Results: Our modeling found limited evidence for seasonality in fever and diarrhea incidence rates. However, there was significant evidence that an increase in attendance was associated with a decrease in fever and an increase in diarrhea incidence. The data also indicated lower fever incidence before the COVID-19 shutdown with an increase in fever incidence as time after shutdown increased.

Conclusion: This study shows evidence of a relationship between rising attendance and increasing transmission events and begins to quantify the impact of CCPs on disease transmission in infants.

Keywords: Infant; Fever; Diarrhea; COVID-19; Observational study

INTRODUCTION

In many family households in the United States today, it is typical for both parents to maintain full-time jobs, whether at home or another workplace, leaving a need for some form of childcare. Enrolling an infant in a childcare program (CCP) is often a necessary step for working families, however, it comes with an increased risk of exposure to diseases for both the infants and their parents. As a result, CCPs and the agencies that license them often have policies in place to reduce the spread of disease. For example, infants affected by diarrhea are prevented from attending CCPs, leaving their parents to either find alternative care or remain at home to care for their ill children. Children attending CCPs are at an increased risk of hospitalization from gastroenteritis within their first 12 months of attendance.[1] Parents are also at risk of being affected by infectious diarrheal and febrile diseases; one study showed that of a combined 28 cases per 100 child-months of diarrheal and respiratory illnesses, the illness was transmitted to parents an average of 6 times.[2] The COVID-19 pandemic brought

evidence-based hygiene to the forefront of the public's consciousness, with a particular focus on increasing diligence to prevent disease transmission.

A COVID-19-related CCP shutdown and subsequent reopening with added sanitary measures in place allowed us a unique opportunity to study the downstream effects directly contrasted against pre-pandemic events. We investigated records, email communications between families and staff, and exposure notices at a university-based CCP between January 2018 and May 2021. Illness events were separated into a "pre-shutdown" and "post-shutdown" period, delineated by its COVID-19 related shutdown which occurred from April through May 2020. The investigation into the email communications consisted of a series of searches for keywords indicating diarrhea or febrile illness. The CCP, according to state licensing requirements,[3] posted exposure notices outside of any rooms with diagnosed infectious diseases to inform parents and staff of infectious disease events.

The objective of this study was to examine diarrheal and febrile disease transmission before and after the COVID-19 CCP closure, when changes in health policies on group sizes, disinfection, and personal protective equipment created a natural experiment. This was to directly test our hypothesis that the reduced class sizes would lead to a reduction in incidence of enteric disease symptoms. A secondary objective was to explore potential causative agents for diarrheal and febrile illnesses causing the observed pattern.

METHODS

Information was gathered by searching the official classroom email accounts of caregivers at the CCP. A keyword search was used to find correspondence between staff and parents pertaining to potential cases of diarrheal disease in infants enrolled at the CCP. Distinction was made between diagnosed diseases (exposure notices) and symptoms noted by caregivers and parents. Additionally, the metadata were examined for number of children present each day, season of the year, pre- versus post-shutdown, and time since shutdown to test our hypothesis in the presence of potential confounding variables. This study used the CCP policy's definition of diarrhea as 3 or more consecutive cases of diarrhea, which closely mirrors the World Health Organization (WHO) definition of 3 or more loose stools in a 24-hour period.

Study Site

The study took place at a CCP run by the Office of Human Resources at The Ohio State University between January 1, 2018, and May 31, 2021. The program cares for children from newborn through 5 years of age. This facility has 3 preschool rooms (age 3 to 5 years), 2 toddler rooms (18 months to 3 years), and 3 infant rooms (newborn to 18 months). The CCP Family Handbook states that infant and toddler rooms have groups up to 10 with a staff-to-child ratio of 1:4 for infants and 1:5 for toddlers, and the preschool rooms have up to 18 children with a 1:9 staff ratio.[3] This study focused on infants up to 18 months of age in the 3 infant rooms.

Study Design and Participants

This CCP was selected because it was a partner center with the university, allowing for ease of access with an existing relationship from a trusted partner. Consent of parents was not required for this study as there were no human subjects involved.

Data Collection

Data (date, room, and symptom) were collected at the individual level, without identifiers to protect the privacy of persons involved, and aggregated by room. The selected daycare has children grouped in cohorts which move together with their caregiver to the next room when they age out of their current room. Therefore, each room is designed and tailored to meet the needs of the age group currently occupying it, while having the same caregiver gives the children some stability. For ease of use, meteorological dates were used to mark the start of a season. This system marks the beginning of a season as being the first day of the month in which the equinoxes and solstices occur.

Email Correspondence

To calculate the incidence of diarrheal disease symptoms in infants at CCP, we examined email data from the center between January 2018 and May 2021. Caregivers in infant rooms at CCP used Microsoft Outlook (Microsoft Outlook for Microsoft 365 MSO, Version 2205 16.0.15225.20172) to communicate with parents about absences and closures. To reduce disease transmission, CCP follows state guidelines on refusing entrance to caregivers and children who exhibit signs of illness, as well as sending home early any children who have at least 101 °F temperature, 3 consecutive diaper changes showing diarrhea, vomiting more than once, or showing other signs of communicable diseases during their time under care.[4] Notifications of early dismissal due to illness are sent from each individual room's designated company email address. In addition, parents often communicate to caregivers through these email addresses if they are keeping their child home due to illness. It is the center's policy to not delete or clear any of their sent or received messages.

There were 2 data collection searches completed using the Outlook desktop application, with the first looking at data from January 1, 2018, to August 31, 2020. For the months of April and May in 2020, the daycare was closed to comply with the nationwide shutdown, so no results were found for this period. The search terms used for the first collection were limited to the keywords "diarrhea" and "fever." Emails retrieved from the search were viewed and data were extracted into a spreadsheet with room number as the only identifier to ensure privacy of the involved individuals. The first search returned 135 emails relating to diarrhea or fever events at CCP. Terms related to vomiting were not used because of the difficulty in differentiating regurgitation and vomiting in infants.

The second search used a date range beginning on May 31, 2021, and going back in 90-day increments to where the previous search had completed. The searches were limited to 90-day increments due to Outlook limiting the number of emails it returns in each pull and the increased volume of email sent during the pandemic because parents were not allowed into the building and could not communicate directly with caregivers. The search terms were established ahead of time using Boolean logic and selected to catch as many potential emails pertaining to sick children and those who were believed to be sick by their parents. Though terms related to vomiting were used in this second search, they were not analyzed here for consistency with the former data set.

Exposure Notices

The information recorded when going through the emails included the initials of the caregivers, the room number, the disease or symptoms, the date, and if the child remained at school or was sent home. Based on state licensing requirements, the facility publishes exposure notices of infectious disease events. Exposure notices are formal notifications from the daycare center sent to parents and posted outside of any affected rooms to inform the parents and staff of clinically confirmed communicable diseases. The information within the notices include disease, date symptoms were first seen, date the disease was diagnosed, incubation duration, typical symptoms, and standard treatment. All the exposure notices released during the study period are detailed in Table 1. The number of days after a holiday that an exposure notice was posted was calculated using the university's academic calendar and the CCP's holiday schedule.

Infant Attendance

Classroom attendance (infant-days) for each day, week, and month were calculated as the number of enrolled infants present at any point during that day per room. Infant-hours breaks the days down into a per room sum of the duration in which the infants were under the caregivers' supervision for that day. The totals for each day were tracked by software at the facility and were provided by the data manager at the request of the project. These data were aggregated for the specific rooms and converted to an overall average for each month within the date range selected for the study. That information was then used to determine the respective monthly incidence rate for diarrhea and fever occurrences, as seen in Figure 1 and their relationship with proposed risk factors.

Data Analysis

A multivariable zero-inflated Poisson regression model was constructed to separately model the incidence of fever and diarrhea reported by email and adjust for the expected extra zeroes within the model from days when there were no reported symptoms. The zero-inflated model in the Political Science Computational Laboratory (PSCL) version 1.5.5 package in RStudio allows for the probability of an outbreak to be calculated in a logistic, zero-inflated, model simultaneously with the Poisson portion modeling the magnitude of an outbreak. The first model (Table 2) examined the probability of the outcome of fever incidence when considering infant-days, the pre- or post-shutdown period, the number of days following the shutdown, and room number as a grouping variable, with seasonality being included as an independent variable for the probability of the outbreak in the zero-inflated Poisson portion of the model. The second zero-inflated Poisson (Table 3) used the same independent variables but substituted the fever incidence rate with the diarrhea incidence rate as the dependent variable.

RESULTS

Of all 3 rooms, 2849 emails were found from the search string used. Of the initial list of emails, 78 in total were retained as being potentially useful for the study, with a breakdown by room in Table 4. A total of 2771 emails were excluded for various reasons, including parents checking up on children, duplicates of or replies to previous emails relevant to the study, or emails regarding pickup at the end of the day instead of early pickup due to illness. Another common issue was that the children were out sick, but with an illness not pertaining to this study. Within the emails that

Table 1. Exposure Notice Diseases and Dates

Disease	Room Identifier	Date Diagnosed
Ringworm	1	07/24/2020
Influenza	2	02/20/2020
Influenza	3	01/18/2020
Conjunctivitis	3	01/18/2020
Diarrheal disease	3	01/15/2020
Roseola	3	09/03/2019
Roseola	2	05/13/2019
Influenza	2	04/01/2019
Strep throat	1	03/14/2019
Roseola	2	02/25/2019
Influenza	1	01/27/2019
Diarrheal disease	2	01/25/2019
Croup	1	10/29/2018
Roseola	1	09/14/2018
Croup	1	03/22/2018
Influenza	3	01/09/2018

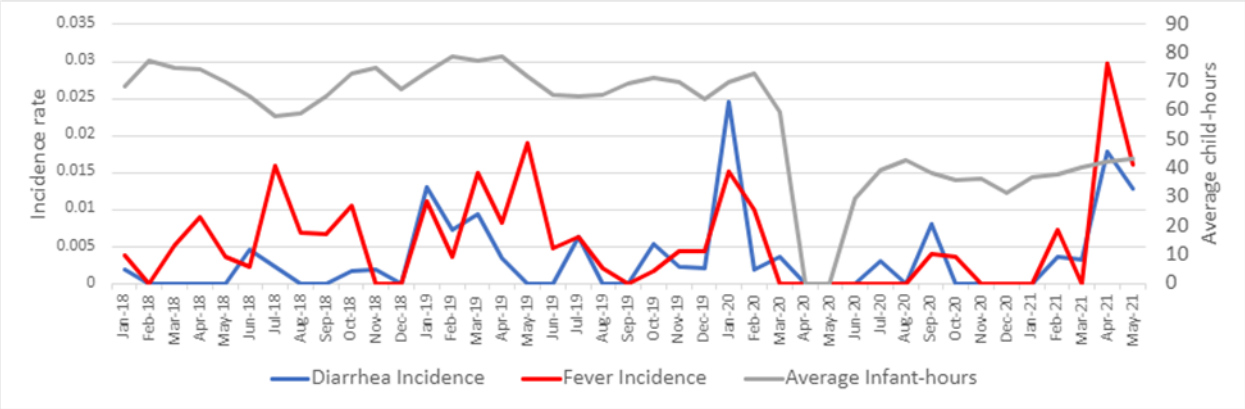

Figure 1. Incidence Rate in Fever and Diarrhea Cases per Infant-Hours by Month Across the Study Period

Table 2. Fever Incidence Using Spring as the Zero-inflated Intercept

Poisson	Log Incidence Rate Ratio	Standard Error	*p*
Intercept	1.434	0.916	0.118
Infant-Days	-0.364	0.104	<0.001*
Post-Shutdown	-7.068	1.924	<0.001*
Days Post-Shutdown	0.019	0.006	0.002*
Room 2	0.473	0.328	0.150
Room 3	0.305	0.328	0.352
Zero-Inflated Poisson	Log Odds	Standard Error	*p*
Intercept	1.128	0.356	0.002*
Fall	0.705	0.462	0.127
Summer	0.915	0.433	0.034*
Winter	0.181	0.407	0.657

Table 3. Diarrhea Incidence Using Spring as the Zero-inflated Intercept

Poisson	Log Incidence Rate Ratio	Standard Error	*p*
Intercept	-1.503	0.885	0.090
Infant-Days	-0.044	0.089	0.623
Post-Shutdown	-2.192	1.053	0.037*
Days Post-Shutdown	0.007	0.004	0.076
Room 2	0.506	0.350	0.148
Room 3	0.308	0.361	0.395
Zero-Inflated Poisson	Log Odds	Standard Error	*p*
Intercept	1.287	0.556	0.021*
Fall	0.745	0.527	0.158
Summer	0.991	0.564	0.079
Winter	-0.210	0.448	0.640

Table 4. Email Inclusion and Exclusion Breakdown by Room

Room	Relevant (*n*)	Excluded (*n*)	Total (*n*)
1	27	714	741
2	35	1554	1589
3	16	503	519
Total	78	2771	2849

were rejected from inclusion, half were for congestion, 11 pertained to vomiting, 1 was for congestion and vomiting, 1 was for an ear infection, 2 related to colds, 1 for a possible urinary tract infection, 1 for lack of sleep, 2 not feeling well, and 1 with no reason given. The ultimate result was a total of 38 relevant events over the 11-month period. These were combined with the 135 emails identified from January 1, 2018, to August 31, 2020, for a total of 173 instances of parent or caregiver reported disease (109 fever and 64 diarrhea). The post-shutdown period's average daily attendance rate across all rooms combined was reduced by 55.6%

while the average daily infant-hours were reduced by 54.7% compared to the period before the closure. Over the full course of the study the 64 cases of diarrhea led to a case-rate of 3.82 per 1000 infant-days with the 109 cases of fever leading to an overall case-rate of 6.52 per 1000 infant-days.

The exposure reports that were discovered were a mean of 18.19 days after a holiday with a median of 15.50 days. The most extreme lag times following a day off were 1 day for roseola in September 2019, and 59 days for roseola in May 2019. There were 9 site closures for holidays in 2018, 10 in 2019, and 2 in 2020 during the study period in which there were no exposure reports sent to parents. Over the course of the study 8 of the 16 exposure notices happened 14 days or fewer after a holiday or closure, with 13 of the 16 (81.25%) happening within 21 days. Email communication about diarrhea and fevers was much more frequent than exposure notices. Exposure notice diseases observed during the study period were influenza, conjunctivitis, roseola, strep throat, croup, thrush, hand foot and mouth disease (HFMD), chicken pox, and respiratory syncytial virus (RSV).

The incidence rates for diarrhea showed a seasonal pattern of late winter and early spring, roughly January to March (Figure 1), before the nationwide shutdown. However, there was an atypically large spike in diarrhea in January 2020, with another atypical spike of both diarrhea and fever in April and May of 2021. Fever incidence rates were lowest in the fall of 2018 and 2019, followed by a large spike in the winter months preceding the closure.

The Poisson analysis for fever incidence in Table 2 showed a significant, negative correlation with increasing infant-days and the number of days after resuming class from the shutdown. A significant, negative correlation when comparing fever incidence rates before the shutdown to after care had resumed was found, meaning that fevers were less likely in the period just after the shutdown. The Poisson analysis for diarrhea incidence in Table 3 showed similar results to Table 2 regarding post-shutdown significance, with the model showing that increasing time after resuming care approached significance. No significant correlation was found between room number and either of the fever or diarrhea incidence rates. The zero-inflated portion of the model for the fever incidence rate showed that only summer was significantly different from the comparator season of spring. There were no significant differences seen in the diarrhea incidence rate analysis for the seasons, but the intercept was significant in both models.

DISCUSSION

Our focus on symptoms for this study suggest that the post shutdown period, which included measures like increased hygiene requirements, fever screenings, and reduced classroom sizes led to a decrease in diarrhea and fever incidence rate. We also found that reducing attendance rates, when controlling for other aspects of the post-shutdown period, was only significant in decreasing fevers with limited evidence for seasonality in either incidence. Our analysis of fever incidence from the zero-inflated Poisson model opposes what traditional literature has shown of seasonality spikes in colder weather leading to more incidences of illness.[5] Additionally, fevers decreased post-shutdown beyond what would be expected just on the basis of decreased attendance, which exceeds what we expected with our hypothesis. For both diarrhea and fever, incidence increased with time post-shutdown. We looked at fever and diarrhea specifically because of the tremendous number of hurdles present for a disease to be clinically diagnosed and reported back to the daycare.

After returning from the planned closure, the university required weekly staff testing for COVID-19 and the daycare increased hygiene requirements and mandated that caregivers wear masks. The spike of diarrhea and fever in 2020 seen in Figure 1 may be linked to the fact that infants tend to experience more COVID-19 related gastrointestinal issues.[6] The larger and apparent propagating pattern of fever and diarrhea spikes seen for 2021 may be due to complacency with the caregivers being less diligent with hygiene, with families starting to interact more with other individuals, or simply the natural propagation of infectious diseases upon remixing of infants and staff post-closure. Some of the incidence increases and exposure notices occur within 2 weeks of a national holiday or university closure, allowing for the potential of transmission from outside of people affiliated with the CCP. However, not all notices and symptoms happened following a day off, meaning that holidays are not a good indicator of exposure for the CCP. We believe it is likely that other transmission events through siblings, parents, caregivers, or other infants were present, keeping in mind that not all outside exposures happen during holidays.

Our results indicate that fevers are more common in the spring and summer compared with the fall and winter, counter to the cold weather seasonality found for 2017 and 2018 by the Centers for Disease Control and Prevention (CDC).[5] Spring was the only significant seasonal association seen in the zero-inflated section of the model for diarrhea, possibly due to the unusually large spike seen in 2021. Future studies may want to consider controlling for COVID-19 prevalence in the surrounding communities. Due to the lower incidence rate observed for diarrhea compared with fevers and a similar directionality in the coefficient estimates, we suspect a larger sample may highlight important underlying relationships not detected in our current analysis.

A significant association between an increase in infant-days and a decrease in fever incidence was found which may have resulted from the facility screening incoming infants for fever upon entry to the facility. Infants who had fevers upon arrival were sent home immediately, so these incident cases would not be observed in the facility email unless parents later communicated about progress at home. There was a significant decrease of fever and diarrhea in the post-shutdown period. The decreased incidences may have been due to increased hygiene requirements after returning and immunity from past acute gastroenteritis infections among infant

groups. There is a significant and positive correlation between days after reopening and fever incidence rate, as reflected in the spike seen in Figure 1. A similar correlation approaches significance in the model for diarrhea. There is no significant difference in either incidence rate among the different rooms, showing that there is no specific room in which fever or diarrhea were more likely.

The exposure notices (Table 1) did not always line up with increases in incidence rates (Figure 1), and when exposure notices were released, it was difficult to associate the illness with the corresponding spike. In January 2018 there was a low fever incidence, but it corresponded with a notice of influenza type A. The same was also seen in September 2019 with roseola and no fevers reported and, in February 2020, with another influenza notice and low fever incidence. This shows that either transmission does not always occur due to effective removal of diagnosed infants from the facility, or it may go unnoticed in the new cases. Conversely, there was a large spike of both fever and diarrhea in January 2020 which corresponds with notices for influenza and a nonspecific diarrheal disease. There was also an increase of fever and diarrheal incidence from December 2018 to January 2019 coinciding with the release of diarrheal disease and influenza exposure notices. February to March 2019 also saw a slight increase in fever incidence along with a confirmed case of strep throat, likewise with April to May 2019 and a clinically confirmed case of roseola. The remaining exposure notices were associated with declines or no change in incidence from month to month. We believe that our work here can contribute to the broader body of work centering around diseases and the importance of hygiene standards within the daycare's role of transmission reduction.

One of the largest limitations of this study is the self-reported nature of parents sending notification emails regarding their child being sick. The study required accurate and timely reporting to track incidence and associate that information with clinically confirmed cases through exposure notices. This was further hindered by a need for caregivers to properly report diarrhea and notice low-grade fevers. The study was also limited by the single CCP as a source of data even though there were 3 rooms surveyed at the CCP. There is also the potential for bias present in the search methods, since the first search period used fewer terms than the second. The less specific search string would lead to underreporting of data during that period with results being closer to the actual number of cases for the second search period. Another potential source of bias is present in the self-reported nature of the email searches leading to underreporting for the entire period of the study.

PUBLIC HEALTH IMPLICATIONS

The conditions presented by the COVID-19 pandemic and nationwide shutdown allowed for a unique opportunity for a natural experiment. In this study, fever and diarrhea transmission in a daycare setting were examined for any potential relationship with seasonality and attendance rates. A significant relationship between incidence rates and child attendance was found to be present, while there were mixed results relating to seasonality. This study also suggests that there is a lag between mixing of children in daycare and increasing incidence of disease which may relate to pathogen incubation, generation intervals, or fading compliance with hygiene protocols. This study suggests that diarrheal and febrile illness incidence immediately following the nationwide closure was reduced beyond what could be expected from decreased attendance alone. Future studies should look at a broader range of daycares with more children included, as well as testing attendees and staff for specific diseases to discriminate potential outbreaks of multiple diseases.

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AUTHOR CONTRIBUTION

Jeremiah Cox: primary author and researcher. Matthew Salerno: secondary researcher. Jenessa Winston and Kelly Baker: expertise contributors. Jiyoung Lee and Rebecca Garabed: co-principal investigators.

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RESEARCH ARTICLE

The Association of Social Factors, Barriers to Care, and Stress Among Postpartum Women Within Racial Groups

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ABSTRACT

Background: The purpose of this study is to identify barriers to care associated with stress among postpartum women within racial groups.

Methods: Paper questionnaires were distributed to English-speaking postpartum women, aged 18 years or older. The questionnaire included demographic questions, a resiliency assessment, and a list of barriers to care. Participants marked which barriers were problematic, including feeling overwhelmed by stress.

Results: One hundred and nine completed questionnaires were returned. Participants were 61% White and 27% Black-identifying women. Participants reporting being overwhelmed by stress (SP-stress problem) were similar to participants who were not overwhelmed by stress (NSP-no stress problem) on education and marital status. Overall, the SP group reported more problems with other barriers to care than the NSP group. Within race, Black-identifying and White SP participants reported higher rates of not having enough money (Black-identifying: SP 45% vs NSP 0%; p=.03 and White: SP 31% vs NSP 7%; p=.02) and feeling too tired for everyday activities (Black-identifying: SP 50% vs NSP 0%; p=.01 and White: SP 50% vs NSP 10%; p<.001) than same race participants in the NSP group. Black-identifying SP participants reported higher rates for problems getting places than Black-identifying NSP participants (Black-identifying: SP 40% vs NSP 0%, p=.03). White SP participants had higher rates for problems finding childcare than white NSP participants (White: SP 36% vs NSP 3%; p<.001).

Conclusion: This study highlights the differential racial experience of barriers to care among stressed and nonstressed women. Addressing the systemic inequalities underlying psychological stress during the perinatal period is necessary for delivering equitable care.

Keywords: Stress; Barriers to care; Health disparities; Survey research

INTRODUCTION

Pregnant individuals frequently report high levels of stress related to barriers in accessing health care, including financial instability and a perceived lack of support from social networks.[1–3] Stress experienced during pregnancy significantly increases the risk of maternal mental health disorders and adverse maternal and birth outcomes such as hypertensive disorders of pregnancy, postpartum depression, preterm birth, and low birth weight. These outcomes are known to be disproportionally higher among Black women.[2,4–7] Despite its significance, the relationship between stress and barriers to care during pregnancy within racial groups remains inadequately explored.[6,8–14] In addition, current state level

assessments, eg, the Behavioral Risk Factor Surveillance System (BRFSS), the Pregnancy Risk Assessment Monitoring System (PRAMS), and the Ohio Medicaid Assessment Survey (OMAS), lack data on systemic barriers and do not typically include postpartum individuals in their target populations.[15–17]

Sources of stress during pregnancy, such as financial stress, dissatisfaction with relationships and lifetime experiences of discrimination, and protective factors, such as resilience and social support, have been reported among marginalized populations, including Black and Latinx women.[1,2,4,6–9,12,18–23] The biological consequences of chronic stressors—stemming from historical and ongoing racism, low education levels, and exposure to violence—have been well-documented and contribute to the racial disparities observed in pregnancy outcomes.[5,21,24] Reducing stress has been shown to increase resilience, emphasizing the importance of interventions that address social determinants of health (SDoH) for individuals facing such barriers to care.[6,25,26] Pregnant women with higher resilience tend to experience fewer depressive symptoms, lower perceived stress, and greater interpersonal support. In contrast, women with maladaptive coping skills are at increased risk for engaging in fewer positive health behaviors, such as exercise and stress management, during pregnancy.[3,4,8,9,19,23,27]

Similar levels of stress (none, low to moderate, and high) during pregnancy have been reported in the literature for Black and White women, with common stress sources including partner-related issues, excessive responsibilities, concerns about their baby and other children, and financial strain.[11] However, the primary source of stress differs between these groups, with financial concerns being the top stressor for Black women, compared to work-related stress for White women.[11] Studies focusing on Black and Latinx women highlight additional sources of stress that are not commonly reported in the literature, such as concerns about safety, raising Black children, being the head of the household, challenges with breastfeeding, difficulty with relaxation and sleep, and experiences of discrimination both over their lifetime and during prenatal care.[1,14,22]

Social factors, including societal structures, community-level systems, and interpersonal level stressors, affect historically marginalized groups in distinct ways. Black women often experience higher stress levels due to these compounded social factors, which can substantially amplify the experience and consequences of stress during pregnancy.[18,19,24] With maternal morbidity and mortality rates 3 times higher among Black women than among White women, further research is needed to explore the differential experiences and sources of stress among pregnant women across and within racial groups.[28] The purpose of this study is to identify social factors associated with stress levels among postpartum women within 3 racial groups.

METHODS

Postpartum women aged 18 years or older who delivered at a large hospital in southwest Ohio between 2017 and 2019 and were able to read and understand English were eligible to participate in the study. Participants were asked to complete an anonymous 3-part questionnaire prior to hospital discharge after delivery. A member of the study team explained the purpose of the study and answered any questions. The survey took approximately 25 minutes to complete. Participants filled out the paper questionnaire and returned it to their nurse in a sealed envelope. The nursing staff then placed the envelope into a collection box for the research team to retrieve. A study team member entered responses from the questionnaires into REDCap.[29] The study was approved by the Wright State University institutional review board (#6114).

The questionnaire included a consent cover letter, demographic questions (eg, age, race, number of children, living situation), a resiliency assessment, and a list of barriers to care. These barriers included transportation, food insecurity, financial insecurities, feeling overwhelmed by stress, lack of support from family or friends, fatigue affecting daily activities, childcare availability, and insufficient time for doctor appointments. Participants were asked to indicate whether each barrier was a problem and how frequently it occurred. Barriers were coded into categories for No, not a problem and Yes, a problem at least some of the time. Resilience was measured using Snyder's cognitive model of hope questionnaire which generates scores for agency (confidence in one's ability to reach goals) and pathway (knowing what steps to take to reach goals). Scores are continuous variables ranging from 4 to 32, with higher scores indicating greater hope or resilience.[30]

Data were analyzed using descriptive statistics, including chi-square tests and Fisher exact tests, for categorical data, and analysis of variance (ANOVA) for continuous data. All statistical analyses were conducted using SPSS version 29.0 (IBM, Armonk, NY).

RESULTS

Of the 114 surveys collected, 5 were incomplete, resulting in 109 completed surveys available for analysis. The racial distribution of participants was Black-identifying (27%), White (61%) and Other race (12%), which included Hispanic/Latino, Asian, mixed race, or other racial identities. No significant differences were observed among racial groups in terms of age category ($p = .12$), parity ($p = .13$), number of children living at home ($p = .30$), or the presence of a mental health condition ($p = .53$; Table 1). However, significant differences were found in education level ($p = .005$), marital status ($p < .001$), living arrangement ($p = .002$), and type of medical insurance ($p < .001$).

Participants were categorized based on their response to the barrier "I feel overwhelmed by stress" into those who reported feeling overwhelmed by stress at least some of the time [stress problem (SP) group; 56%] and those who did not [no stress problem (NSP) group; 44%]. Overall, participants in the SP group did not differ from those in the NSP group regarding social factors such as marital status, education level, living arrangement, parity, or the

Table 1. Demographic Characteristics of Survey Participants by Race and Nationality

	Black-identifying (N=29)	White (N=67)	Other Race/ Ethnicity (N=13)	p
Age				.12
18-27	22 (76%)	31 (46%)	7 (54%)	
28-35	5 (17%)	29 (43%)	5 (38%)	
> 35	2 (7%)	7 (11%)	1 (8%)	
Highest education completed				.005
Some/Completed high school	20 (69%)	20 (30%)	8 (61%)	
Some college	6 (21%)	28 (42%)	4 (31%)	
Completed 4+ years college	3 (10%)	19 (28%)	1 (8%)	
Marital status				<.001
Single	25 (86%)	23 (34%)	8 (61%)	
Married	4 (14%)	42 (63%)	4 (31%)	
Divorced	0	2 (3%)	1 (8%)	
Living Arrangement				.002
Living alone	12 (41%)	7 (10%)	2 (15%)	
Living with partner	10 (35%)	54 (81%)	10 (77%)	
Living with family	5 (17%)	5 (8%)	1 (8%)	
Living with friends	2 (7%)	1 (1%)	0	
Parity				.13
Nulliparous	9 (31%)	24 (36%)	1 (8%)	
Multiparous	20 (69%)	43 (64%)	12 (92%)	
Children living at home				.30
1 child	9 (32%)	24 (37%)	2 (15%)	
2+ children	19 (68%)	40 (63%)	11 (85%)	
Type of insurance				<.001
Government	25 (86%)	29 (43%)	5 (38%)	
Private	4 (14%)	36 (54%)	4 (31%)	
Self-Pay	0	2 (3%)	4 (31%)	
Reported having a mental health condition	7 (24%)	20 (30%)	2 (15%)	.53
Reported being overwhelmed by stress	20 (69%)	36 (54%)	5 (39%)	.15

Table 2. Social Factors for Postpartum Women by Race and Stress

	All Races Combined (N=109)			Black-identifying (N=29)			White (N=67)			Other Race/Ethnicity (N=13)		
Social factors (% women in social categories)	**NSP (n=48)**	**SP (n=61)**	**p**	**NSP (n=9)**	**SP (n=20)**	**p**	**NSP (n=31)**	**SP (n=36)**	**p**	**NSP (n=8)**	**SP (n=5)**	**p**
Marital status			.50			.28			.17			.30
Single	22 (46%)	34 (56%)		9 (100%)	16 (80%)		7 (23%)	16 (44%)		6 (75%)	2 (40%)	
Married	25 (52%)	25 (41%)		0	4 (20%)		23 (74%)	19 (53%)		2 (25%)	2 (40%)	
Divorced	1 (2%)	2 (3%)		-	-		1 (3%)	1 (3%)		0	1 (20%)	
Highest education			.91			.26			.73			.65
Some/completed high school	21 (44%)	27 (44%)		8 (89%)	12 (60%)		8 (26%)	12 (33%)		5 (63%)	3 (60%)	
Some college				1 (11%)	5 (25%)		13 (42%)	15 (42%)		3 (25%)	2 (40%)	
Completed 4+ years college	16 (33%)	22 (36%)		0	3 (15%)		10 (32%)	9 (25%)		1 (12%)	0	
	11 (23%)	12 (20%)										
Type of insurance			.23			.57			.78			.77
Government	22 (46%)	37 (61%)		7 (78%)	18 (90%)		12 (39%)	17 (47%)		3 (37%)	2 (40%)	
Private	22 (46%)	22 (36%)		2 (22%)	2 (10%)		18 (58%)	18 (50%)		2 (25%)	2 (40%)	
Self-Pay	4 (8%)	2 (3%)					1 (3%)	1 3%)		3 (37%)	1 (20%)	
Living arrangement			.33			.38			.12			.37
Alone	7 (15%)	14 (23%)		3 (33%)	9 (45%)		3 (10%)	4 (11%)		1 (13%)	1 (20%)	
With partner	37 (77%)	37 (61%)		2 (22%)	8 (40%)		28 (90%)	26 (72%)		7 (87%)	3 (60%)	
With family	3 (6%)	8 (13%)		3 (33%)	2 (10%)		0	5 (14%)		0	1 (20%)	
With friends	1 (2%)	2 (3%)		1 (11%)	1 (5%)		0	1 (3%)		--	--	
Parity			.53			.40			.13			1.0
Nulliparous	13 (27%)	21 (34%)		4 (44%)	5 (25%)		8 (26%)	16 (44%)		1 (13%)	0	
Multiparous	35 (73%)	40 (66%)		5 (56%)	15 (75%)		23 (74%)	20 (56%)		7 (87%)	5 (100%)	
Children living at home			.30			1.0			.21			1.0
1 child												
2+ children	13 (28%)	22 (38%)		3 (37%)	6 (30%)		9 (29%)	15 (45%)		1 (13%)	1 (20%)	
	34 (72%)	36 (62%)		5 (63%)	14 (70%)		22 (71%)	18 (55%)		7 (87%)	4 (80%)	
Reported having a mental			.05			.38			.29			.13
health condition	8 (17%)	21 (34%)		1 (11%)	6 (30%)		7 (23%)	13 (36%)		0	2 (40%)	

number of children living at home (Table 2). However, participants in the SP group reported significantly higher rates of experiencing problems with all other barriers to care compared to the NSP group (Table 3), with the exception of feeling unsupported by friends (p = .06). Racial groups and groups compared by stress did not differ on resilience, although pathway scores were consistently lower than agency scores for all groups (Table 3).

Within racial groups, participants in the SP group were similar to their same-race counterparts in the NSP group regarding demographic and social factors (Table 2). Black-identifying participants in the SP group were significantly more likely to report problems with transportation (Black-identifying: SP 40% vs NSP 0%; p = .03), financial difficulties (Black-identifying: SP 45% vs NSP 0%; p = .03), and fatigue affecting daily activities (Black-identifying: SP 50% vs NSP 0%; p = .01) compared to Black-identifying participants in the NSP group (Table 3). White participants in the SP group were significantly more likely to report financial difficulties (White: SP 31% vs NSP 7%; p = .02), fatigue impacting daily activities (White: SP 50% vs NSP 10%; p < .001), and challenges in finding childcare when needed (White: SP 36% vs NSP 3%; p < .001) compared to White participants in the NSP group. Participants of Other race/Ethnicity in the SP group were significantly more likely to report problems with transportation (Other race/Ethnicity: SP 60% vs NSP 0%; p = .04) and financial difficulties (Other race/Ethnicity: SP 50% vs NSP 0%; p = .03) compared to their counterparts in the NSP group.

DISCUSSION

Our study reveals that postpartum individuals who reported feeling overwhelmed by stress were more likely to experience additional barriers to care compared to those who did not report being overwhelmed by stress. Further examination within racial groups showed that compared to their same-race counterparts without stress, Black-identifying, and Other-race women with stress were more likely to report transportation challenges. Additionally, Black-identifying and White participants with stress reported feeling too tired for everyday activities, while only White participants with stress reported difficulties in finding childcare. Within all 3 racial groups, women with stress were more likely to experience financial challenges compared to those without stress.

Our findings contribute to the existing literature and address data gaps in current state level assessments, including the BRFSS, PRAMS, and OMAS, by highlighting racial differences in the types of barriers to care faced by women overwhelmed by stress compared to their same-race counterparts who were not overwhelmed by stress.[15–17] While our overall results align with previous research identifying financial constraints and inadequate support systems as major stressors for pregnant individuals, our race-specific analyses provide new insights into the specific barriers experienced by women with stress within different racial groups.[1,2,6,11–13] These findings deepen our understanding of maternal stress in Ohio by illustrating how the experience of stress,

Table 3. Resiliency and Barriers to Care* for Postpartum Women by Race and Stress

	All Races Combined (N=109)			Black-identifying (N=29)			White (N=67)			Other Race/Ethnicity (N=13)		
	NSP (n=48)	SP (n=61)	p	NSP (n=9)	SP (n=20)	p	NSP (n=31)	SP (n=36)	p	NSP (n=8)	SP (n=5)	p
Resilience Scores												
Agency Score	28.3 ± 3.0	26.0 ± 4.2	.09	28.1 ± 3.3	27.2 ± 3.5		28.4 ± 2.8	25.2 ± 4.6		27.7 ± 3.6	27.2 ± 3.2	
Pathway Score	27.4 ± 3.7	25.3 ± 4.9		26.0 ± 5.4	24.7 ± 4.8		27.9 ± 3.3	25.3 ± 5.0		27.1 ± 3.2	28.2 ± 3.8	
Agency Scores – Stress main effect p=.09; Race main effect p=.58; Stress by Race interaction p=.25 Pathway Scores – Stress main effect p=.39; Race main effect p=.28; Stress by Race interaction p=.39												
Barriers to Care												
Getting places is difficult for me	3 (6%)	17 (28%)	.005	0	8 (40%)	.03	3 (10%)	6 (17%)	.49	0	3 (60%)	.04
I don't have enough to eat	1 (2%)	9 (15%)	.04	1 (11%)	6 (30%)	.38	0	2 (6%)	.49	0	1 (20%)	.39
I don't have enough money and I have to go without things I need	2 (4%)	23 (38%)	<.001	0	9 (45%)	.03	2 (7%)	11 (31%)	.02	0	3 (50%)	.03
I feel that my family doesn't support me	0	12 (20%)	.001	0	6 (30%)	.14	0	5 (14%)	.06	0	1 (20%)	.39
I feel that my friends don't support me	2 (4%)	10 (16%)	.06	2 (22%)	6 (30%)	1.0	0	2 (6%)	.50	0	2 (40%)	.13
I feel too tired for everyday activities	4 (8%)	30 (49%)	<.001	0	10 (50%)	.01	3 (10%)	18 (50%)	<.001	1 (13%)	2 (40%)	.51
I am able to get child-care when I need it	3 (6%)	21 (34%)	<.001	2 (22%)	6 (30%)	1.0	1 (3%)	13 (36%)	<.001	0	2 (40%)	.13
I don't have enough time to go to the doctor	0	13 (21%)	<.001	0	6 (30%)	.14	0	5 (14%)	.06	0	2 (40%)	.13

*Values for barriers to care represent the percentage of women reporting that the barrier is a problem for them at least some of the time.

and the resulting barriers to care, differ across racial groups in the postpartum period. Our results build on recent Ohio-based studies that document racial disparities in maternal outcomes, offering a more detailed look into how stress uniquely shapes the postpartum experiences of new mothers within this regional context.[31,32] These differences emphasize the need for targeted interventions to address the unique stressors faced by each racial and ethnic group.[3,11,14,18,22,24]

However, our study has several limitations. The list of barriers to care did not fully capture some of the specific stressors experienced by Black-identifying and Other-race women. Further research is needed to explore the impact of discrimination on stress in these populations. Additionally, the small sample size and unequal group distribution, particularly for the Other Race/Ethnicity group, limit the generalizability of our findings. The inclusion criteria, which required participants to read and understand English, further limited the conclusions. Future research should incorporate more diverse racial and ethnic categories to better understand the unique stressors faced by different pregnant populations, including the role of discrimination in stress and maternal health outcomes.

PUBLIC HEALTH IMPLICATIONS

Our findings emphasize the relationship between barriers to care and stress among postpartum women, highlighting the differential experience of these barriers across racial groups. Public health initiatives and policy reforms must address barriers that limit access to community support and resources for pregnant and postpartum women. Efforts to reduce stress levels should be tailored to specific racial groups to improve equitable access to both medical and psychological care. Stress management programs should be tailored to the unique needs of pregnant individuals and made accessible through community centers, online platforms, and mobile health units. However, further investigation into the root causes of stress among pregnant and postpartum women is essential. Public health strategies should focus on establishing robust community support networks and enhancing connections to available resources that meet the distinct needs of different patient populations.

Addressing financial barriers requires expanding financial assistance programs, such as subsidies for transportation, childcare, and other essential services. Advocacy efforts should push for policy reforms that promote financial stability, including paid maternity leave and affordable childcare, to alleviate financial burdens on new mothers. Health care systems, providers, and communities must recognize the diversity of the populations they serve and adapt their approaches accordingly. Public health and community-wide efforts should encourage and support healthy behaviors such as stress management strategies, financial literacy education, and social support networks to meet the varied needs of pregnant and postpartum women in Ohio.

CONFLICTS OF INTEREST

The authors have no relevant financial or non-financial interests to disclose.

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AUTHOR CONTRIBUTION

Araam E. Abboud: formal analysis, visualization, writing-original draft, writing-review and editing ; Katie M. Whitehead: formal analysis, visualization, writing-original draft, writing-review and editing; Katherine E. Wilcher: formal analysis, data curation, visualization, writing-original draft, writing-review and editing; Laura A. Bute: formal analysis, visualization, writing-original draft, writing-review and editing; David N. Dhanraj: investigation, formal analysis, writing-review and editing; G. Theodore Talbot: conceptualization, methodological development, data collection, investigation, supervision, writing-review and editing; Rose A. Maxwell: conceptualization, methodological development, data collection, formal analysis, investigation, data curation, project administration, supervision, writing-original draft, writing-review and editing.

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RESEARCH ARTICLE

Hopeful Future Expectations Post-COVID-19 Pandemic Among Youth

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ABSTRACT

Background: Future expectations have been identified as a strong predictor of positive youth development and behavior. Adolescents who anticipate a negative future are more likely to engage in problem behaviors like delinquency, substance use, and risky sexual behavior. The main purpose of this study was to evaluate hopeful future expectations (HFE) of adolescents and young adults (AYA) post COVID-19 pandemic.

Methods: An anonymous cross-sectional online survey was sent to AYA aged 16-21 years in 2022, living in Ohio. Hopeful future expectations, Revised Life Orientation Test (LOT-R), and the 2-item version of the Connor–Davidson Resilience Scale (CD-RISC2) were used to provide overall HFE, resilience, and dispositional optimism scores. Hierarchical clustering and regression models were employed.

Results: A 30% response rate was achieved (468 participants) with 69% (324) Caucasian/White and 51% (239) female. Prior diagnosis with a chronic disease was reported in 20% (96) of participants, and 16% (77) were former or current e-cigarette users. Three clusters were identified in the hierarchical analysis. The low HFE level contained 14.7% (62) of participants, while the moderate and high HFE levels contained 39.2% (166) and 46.8% (198) of participants, respectively. Regression analysis results indicated a collective significant effect of resilience, dispositional optimism, sex, participant educational level, religion, general health, e-cigarette use, and COVID-19 testing on HFE. At the end of the questionnaire, 32 participants provided comments on aspects of the COVID-19 pandemic that were not addressed in the survey.

Conclusion: Our findings provided HFE estimates among AYA, including minority groups, providing insights of the effect of a public health crisis on this population. The development of preventive programs and early interventions are warranted during a public health crisis. Cultural differences with respect to parenting and future orientation, participation in sport activities, mentorship, and social engagement in the local community may yield different levels of HFE

Keywords: Adolescents; Young adults; Hopeful future expectations; Resilience

INTRODUCTION

Adolescence is an intense period of development characterized by the sometimes challenging transition between childhood and adulthood. The intensity of development increases as youth begin to think about adulthood and future expectations.[1] The developmental task of building expectations for the future is especially complex for adolescents and young adults (AYA), even for those living within a society that provides considerable educational and professional opportunities. This period crystalizes during later phases of adolescence, as AYA engage in career exploration and prepare for transitions from school to college or the work

environment and attempt to establish more adult responsibilities.[2,3] This is a challenging developmental period, but one that is also susceptible to interruptions that potentially impact future growth trajectories.

Experiencing the impact caused by a public health crisis such as the recent COVID-19 pandemic is an example of an interruption that might have affected how young people feel about their future. However, our understanding of the impact of the COVID-19 pandemic is incomplete as research findings are limited. Data from the Global Survey on Youth and COVID-19 that interviewed 12 000 respondents from 112 countries indicated young people 18-29 years of age reported feeling optimistic about the future rarely or none of the time (31%), compared to respondents 30-34 years of age (26%).[4] Twenty percent of respondents were representatives of minority groups, however most of the survey results were only reported by gender and age group. Research in a few countries have reported low future expectations and worry about the future among adolescents during the pandemic period.[5-9]

Future expectations, or the extent to which one expects an event to occur, have been identified as strong predictors of positive youth development,[10] and important predictors of adolescent behavior.[11] Higher career aspirations, for example, are a marker for teenagers' well-being and self-efficacy. As observed by Dudovitz and colleagues, aspirations requiring high levels of education are associated with decreased odds of alcohol and substance use and decreased engagement in risky sexual behavior.[12] Conversely, adolescents who anticipate a negative future were more likely to engage in problem behaviors like delinquency, substance use, and risky sexual behavior.[13] Positive beliefs about the future represent an internalization of hope and optimism about future outcomes that manifest as a sequence of goal-associated thoughts and motivations that improve planning pathways, self-confidence, mastery, and goal-directed behavior.[14] They are also associated with better social and emotional outcomes such as adjustment at school[15] and lower depressive symptoms.[16]

In the literature, dispositional optimism is described as the predisposition to expect positive outcomes when confronting major problems across key life domains, resulting in expectations that goals will be attained even in the face of adversity.[17-20] Research has suggested that being optimistic is associated with having good future expectations as an essential factor in adaptation to traumatic or stressful situations.[21,22] For instance, dispositional optimism was linked to the judgment of positive and future life events among undergraduate students.[23] Recent research on optimism has highlighted the important role of optimism on the physical and mental health of AYA minorities,[24] and an important positive cognition associated with suicidal ideation for African American and Latino American college students.[25]

Several studies have shown a significant relationship between resilience and optimism.[26-28] Taken together, optimism and resilience can be seen as positive personality traits. The concept of resilience can be defined as the ability to adapt and cope successfully despite threatening or challenging situations.[29,30] According to Connor and Davidson, resilience varies with context, time, age, and gender.[31] Indeed, all youths experience numerous hardships such as change of school, physical illness, and change in family dynamics that provide opportunities to build personal resilience skills. In more extreme situations, some hardships can cause greater challenges and inhibit development.[32]

Many studies have identified the risks to adolescent mental health posed by the COVID-19 pandemic, yet future expectations in American population have not been sufficiently studied. The purpose of the present study is to investigate hopeful future expectations (HFE) in association with resilience and optimism among AYA during the COVID-19 pandemic. The study of HFE among AYA is essential to provide additional insights to enable future research to help AYA adapt to unparalleled crises and continue pursuing future career expectations when facing major life adversities. Whether dispositional optimism and resilience have a protective effect among AYA regarding future expectations during a pandemic is unknown.

METHODS

Participants

The included participants were AYA between 16-21 years of age who had at least one visit between January and December 2021 at any sites associated with a large children's hospital in Ohio. Any AYA unable to read English sufficiently to participate were excluded. The use of ICD-10 codes was implemented to identify and exclude potential participants with recorded information on developmental disabilities. Sample size calculations were based on the expectation that 30% of respondents would report high HFE. A total of 1646 survey invitations were mailed to a random selection of participants. The invitation letter was mailed with a link to the REDCap (Research Electronic Data Capture) survey, and, to enhance participant response, a $5 gift card claim code was included. Two reminder letters to encourage participation were sent about 2 weeks apart. Survey responses were collected between April and June 2022. The survey participation was anonymous. This study was approved by the Akron Children's Hospital institutional review board where this project was conducted.

Measures

The questionnaire was self-administered, comprised of a combination of multiple-choice questions, Likert scale questions, and open-ended questions. Questionnaire items were developed from literature, with many measures having established face validity. Nonetheless, the questionnaire was pretested to assess its readability and, based on the feedback from 6 participants, a few adjustments were made to the original questionnaire. Specific measures included HFE, Revised Life Orientation Test (LOT-R), and the 2-item version of the Connor–Davidson Resilience Scale (CD-RISC2).

Hopeful Future Expectations (HFE). This instrument was designed for the 4-H Study of Positive Youth Development[16] with a total of 12 items. The final scale score is a mean of the items in the scale, with a range of 1 to 5 where higher scores indicate higher expectations of the likelihood that certain future outcomes will occur. Cronbach α for the hopeful future scale are .94 and .95 for grades 7 and 8, respectively.[16] Under the assumption that many participants graduated from high school, 1 item was changed from 'what are your chances to graduate from high school?' to 'what are your chances to graduate from college?'

Revised Life Orientation Test (LOT-R) (optimism and pessimism scale). Total test score was calculated as per guidelines.[18] The LOT-R has been used to provide an overall dispositional optimism score. Research results indicate gender invariance in the LOT–R factor structure.[18] LOT-R has been used in youth populations as indicated in the literature.[33-36] The LOT-R includes 10 items with a 4-point Likert scale[18] (Cronbach α = 0.78).

Two-item version of the Connor–Davidson Resilience Scale (CD-RISC2). The CD-RISC2 is a brief, self-rated measure of resilience with sound psychometric properties.[37] Higher scores indicate higher resilience. It has been used in studies that included youth and adolescents.[38]

The questionnaire also assessed basic demographics, including age, gender, sex, race, ethnicity, religious affiliation, educational level, and a few questions related to general health.

Statistical Methods

Descriptive statistics for continuous variables (mean, standard deviation) and categorical variables (frequency, percentage) are provided. Group comparisons were assessed using *t* test or analysis of variance (ANOVA) for continuous data, and chi-square test or Fisher exact test for categorical data. To get an overview of the correlations between HFE, dispositional optimism, and reliance, Pearson correlation matrix was created. In the absence of cutoff scores for HFE, hierarchical clustering was employed in attempt to identify clusters of participants. Linear regression and ordinal regression models were evaluated and compared to determine the final model that best fits the sample data. Using regression models, it was investigated if resilience and optimism served as protective factors in the association with HFE, adjusting for demographic characteristics and covariates of interest. Analyses were performed in SAS version 9.4 and JMP Pro 14 (SAS Institute Inc.). Statistical significance was set at 5%.

Missing data were imputed using PROC STDIZE in SAS (SAS Institute Inc.). Imputation is recommended for handling missingness, rather than other missing data techniques (eg, listwise deletion), which significantly reduce sample size and potentially bias results.[39] A total of 427 participants answered the LOT-R questions. There were 11 participants with 1 missing value, and no missing pattern was identified. The HFE questions were answered by 428 participants. There were 6 participants with 1 missing value, 5 participants with 2 missing values, 1 participant with 3 missing values, and 1 participant with 4 missing values. No missing pattern was identified, and 426 were included in the missing imputation method. At the end of the questionnaire, 32 participants provided comments on aspects of the pandemic that were not addressed in the questionnaire.

RESULTS

A 30% (468 participants) response rate was achieved. This response rate is consistent with population- and hospital-based patient surveys generally, which typically range between 16% to 80%.[39-43] Most respondents were White (69%, 324) and non-Hispanic (81%, 378). Fifty-one percent were female (239), and 18% (86) self-identified as LGBTQ+ (Table 1). Prior diagnosis with a chronic disease was reported in 20% (96) of participants, and 16% (77) were former or current e-cigarette users.

Hopeful Future Expectations

A total of 19% (89 participants) responded that the COVID-19 pandemic had very much or completely affected how they perceived their future, and 12% (56 participants) stated their lives will never be the same. Mean (SD) HFE was 4.1 (0.7), with minimum and maximum values of 1.8 and 5 points. Participants that self-identified as male, LGBTQ+, and Hispanic reported lower HFE compared to their counterparts. A statistically significant difference in mean HFE score was also observed between participant educational level, parent educational level, religion, cigarette smoking status, e-cigarette use, chronic disease status, COVID-19 vaccine receipt, and perceived risk for severe COVID-19 (Table 2).

In the absence of guidelines to categorize levels of HFE, hierarchical clustering was used to identify clusters of participants with different levels of HFE. Three clusters were identified, which absorbed 86.4% of all variation in HFE scores. A 1-way ANOVA followed by Tukey HSD (honestly significant difference) pairwise test indicated statistically significant differences in the means of HFE between clusters ($p < .001$). The low HFE level contained 62 (14.7%) members, with a mean 3.0 (95% CI: 2.92;3.05), while the moderate and high HFE levels contained 166 (39.2%) and 198 (46.8%) members, with mean 3.82 (95% CI:3.78; 3.85) and 4.73 (95% CI:7.70; 4.77), respectively. Factors associated with HFE levels are shown in Table 3. The HFE level was associated with sexual orientation ($p = 0.0488$), 21% (18) of self-identified LGBTQ+ participants were in the low level of HFE, compared to 11% (33) among heterosexual participants. Levels of HFE were also associated with participant educational level ($p = 0.0002$), parental educational level ($p < .0001$), religion ($p < .0001$), general health ($p < .0001$), and e-cigarette use ($p = 0.0212$). Among participants with low level of HFE, 55% (34) had parents with high school or less education, 50% (31) did not identify with any religion, 19% (12) stated having fair/poor general health, and 29% (18) were former or current e-cigarette users. Although 27% (6) of Hispanic participants had low level of HFE, compared to

Table 1. Demographic Characteristics of Participants, n=468

	n or mean	% or SD
Age group (years)		
16-17	143	30.6
18-21	325	69.5
Sex		
Female	239	51.1
Male	158	33.8
No answer/Prefer not to answer	71	15.2
Sexual orientation		
Heterosexual or straight	301	64.3
LGBTQ+	86	18.4
No answer/Prefer not to answer	81	17.3
Race		
White	324	69.2
African American	33	7.1
Other race group	47	10.1
Prefer not to answer/no answer	64	13.7
Hispanic/Latino(a)		
No	378	80.8
Yes	22	4.7
Prefer not to answer/no answer	68	14.5
Participant highest degree or level of education		
Less than high school	145	31.0
High school graduate	160	34.2
Some college	90	19.2
College graduate or more	12	2.6
Prefer not to answer/no answer	61	13.0
Parents highest degree or level of education		
Less than high school	26	5.6
High school graduate	92	19.7
Some college	75	16.0
College graduate or higher	214	45.7
Prefer not to answer/no answer	61	13.0
General health		
Excellent	76	16.2
Very good	175	37.4
Good	111	23.7
Fair	41	8.8
Poor	5	1.1
Prefer not to answer/no answer	60	12.8
Have been told by a health care professional that I have any of the following chronic diseases[a]		
Pulmonary diseases (such as asthma, emphysema, chronic bronchitis, cystic fibrosis)	49	10.5
Heart condition (such as heart failure, coronary artery disease)	15	3.2
Chronic kidney disease	2	0.4
Diabetes	13	2.8
Sickle cell disease	0	0
Conditions that may weaken your immune system like bone marrow or organ transplant, HIV/AIDS	5	1.1
Cancer	1	0.2
Other	30	6.4
Prefer not to answer/no answer	82	17.5
I have not been told that I have a chronic disease	290	62.0
Have ever smoked cigarettes		
Never	374	79.9
Yes, I am a current smoker	12	2.6
Yes, I am a former smoker	19	4.1
Prefer not to answer/no answer	63	13.5
Have ever used e-cigarettes		
Never	326	69.7
Yes, I am a current user	44	9.4
Yes, I am a former user	33	7.1
Prefer not to answer/no answer	65	13.9
Identify themselves with any of the following religions		
Christianity	210	45.0
Other religion	27	5.8
Atheist/Agnostic/no religion	131	28.0
Prefer not to answer/no answer	100	21.4

[a] Some participants reported more than 1 chronic disease.

Table 2. Hopeful Future Expectation (HFE) Scores by Demographic Characteristics, General Health, Risk Perceptions, and COVID-19 History

	mean (SD)	median (IQR)	*p*
Age group (years)			0.476
16-17	4.2 (0.7)	4.2 (1.1)	
18-21	4.1 (0.7)	4.1 (1.0)	
Sex			0.032
Female	4.2 (0.7)	4.3 (1.1)	
Male	4.0 (0.7)	4.0 (1.0)	
LGBTQ+			0.017
No	4.2(0.7)	4.3 (1.1)	
Yes	4.0 (0.7)	4.0 (1.2)	
Race			0.134
Caucasian/White	4.1 (0.7)	4.2 (1.1)	
African American	4.1 (0.6)	4.3 (0.8)	
Other race	3.9 (0.8)	3.9 (1.3)	
Ethnicity			0.012
Non-Hispanic	4.1 (0.7)	4.2(1.0)	
Hispanic	3.8 (0.8)	3.8 (1.4)	
Participant educational level			<.0001
High school or less	4.0 (0.7)	4.0 (1.2)	
Some college or higher	4.4 (0.6)	4.5 (1.0)	
Parent educational level			<.0001
High school or less	3.9 (0.8)	3.8 (1.4)	
Some college or higher	4.2 (0.6)	4.3 (0.9)	
Religion			<.0001
No religion/Agnostic	3.9 (0.7)	3.8 (1.0)	
Christianity	4.3 (0.6)	4.4 (1.0)	
Other religion	3.8 (0.7)	3.7 (1.6)	
Cigarette smoker			0.026
Never	4.1 (0.7)	4.2 (1.0)	
Current smoker/former smoker	3.9 (0.8)	3.6 (1.5)	
E-cigarette user			0.005
Never	4.2 (0.7)	4.2 (1.0)	
Current user/former user	3.9 (0.7)	3.9 (1.3)	
General health			<.0001
Excellent/Very good/Good	4.2 (0.7)	4.3 (1.1)	
Fair/Poor	3.6 (0.6)	3.6 (0.9)	
Been told that I have a chronic disease			0.016
No	4.2 (0.7)	4.2 (1.2)	
Yes	4.0 (0.7)	4 (1.1)	
Chances that you will be infected in the next 3 months if you don't take any preventive measures (risk clusters)			0.844
Low	4.1 (0.7)	4.1 (1.1)	
Moderate	4.1 (0.7)	4.2 (1.0)	
High	4.2 (0.7)	4.3 (1.1)	
What would be your chances of developing severe COVID-19?			0.044
Low/very low	4.2 (0.6)	4.2 (1.1)	
Moderate	4.1 (0.8)	4.2 (1.5)	
Very high/high	3.9 (0.80	3.9 (1.1)	
In general, how severe you think COVID-19 disease is?			0.272
Not at all serious/slightly serious	4.0 (0.7)	4.1 (1.1)	
Moderately serious	4.1 (0.7)	4.1 (1.0)	
Severely serious	4.2 (0.7)	4.3 (1.1)	
Tested for COVID-19			0.099
Never tested	4.1 (0.7)	4.2 (1.1)	
Yes, negative	4.1 (0.7)	4.0 (1.2)	
Yes, positive	4.2 (0.6)	4.3 (1.0)	
Have received at least 1 dose of COVID-19 vaccine			0.001
No	4.0 (0.7)	4.0 (1.2)	
Yes	4.2 (0.60	4.2 (1.1)	

Table 3. Hopeful Future Expectation (HFE) Levels by Demographic Characteristics, n=426

	HFE LEVELS			
	LOW (n=62) n (%) or mean (SD)	MODERATE (n=166) n (%) or mean (SD)	HIGH (n=198) n (%) or mean (SD)	*p*
Age group (years)				0.849
16-17	18 (13.6)	50 (37.9)	64 (48.5)	
18-21	44 (15.0)	116 (39.5)	134 (45.5)	
Sex				0.167
Female	31 (13.3)	81 (34.8)	121 (51.9)	
Male	23 (14.7)	67 (43.0)	66 (42.3)	
No answer	8 (21.6)	18 (48.7)	11 (29.7)	
Sexual orientation: LGBTQ+				0.048
No	33 (11.2)	112 (38.1)	149 (50.7)	
Yes	18 (20.9)	33 (38.4)	35 (40.7)	
No answer	11 (23.9)	21 (45.7)	14 (30.4)	
Race				0.287
Caucasian/White	43 (13.5)	121 (38.1)	154 (48.4)	
African American	4 (12.1)	12 (36.4)	17 (51.5)	
Other race	11 (23.9)	19 (41.3)	16 (34.8)	
No answer	4 (13.8)	14 (48.3)	11 (37.9)	
Ethnicity				0.083
Non-Hispanic	51 (13.8)	139 (37.5)	181 (48.8)	
Hispanic	6 (27.3)	10 (45.5)	6 (27.3)	
No answer	5 (15.2)	17 (51.5)	11 (33.3)	
Participant educational level				0.002
High School or less	54 (18.1)	118 (39.6)	126 (42.3)	
Some college or higher	4 (4.0)	34 (33.7)	63 (62.4)	
No answer	4 (14.8)	14 (51.9)	9 (33.3)	
Parent educational level				<.0001
High School or less	34 (29.1)	40 (34.2)	43 (36.8)	
Some college or higher	24 (8.5)	113 (40.1)	145 (51.4)	
No answer	4 (14.8)	13 (48.2)	10 (37.0)	
Religion				<.0001
No religion	31 (24.2)	59 (46.1)	38 (29.7)	
Christianity	15 (6.9)	72 (33.3)	129 (59.7)	
Other religion	6 (33.3)	6 (33.3)	6 (33.3)	
No answer	10 (15.6)	29 (45.3)	25 (39.1)	
Cigarette smoker				0.201
Never	50 (13.6)	141 (38.3)	177 (48.1)	
Current smoker/former smoker	7 (25.0)	11(39.3)	10 (35.7)	
No answer	5 (16.7)	14 (46.7)	11 (36.7)	
E-cigarette user				0.021
Never	38 (11.9)	124 (38.9)	157 (49.2)	
Current user/former user	18 (24.0)	28 (37.3)	29 (38.7)	
No answer	6 (18.8)	14 (43.8)	12 (37.5)	
General health				<.0001
Excellent/Very good/Good	46 (13.0)	126 (35.5)	183 (51.6)	
Fair/Poor	12 (27.3)	26 (59.1)	6 (13.6)	
no answer	4 (14.8)	14 (51.9)	9 (33.3)	
Been told by a health care professional that I have a chronic disease				0.075
No	36 (12.5)	109 (37.9)	143 (49.7)	
Yes	24 (19.1)	53 (42.1)	49 (38.9)	
No answer	2 (16.7)	4 (33.30	6 (50.0)	
LOT-R (Optimism) Score	10.7 (3.6)	12.6 (3.5)	14.6 (3.6)	<.0001
CD-RISC 2 (Resilience) Score	4.6 (1.7)	5.7 (1.4)	6.1 (1.5)	<.0001
What would be your chances of developing severe COVID-19 ?				0.001
Low/very low	31 (10.7)	119 (40.9)	141 (48.5)	
Moderate	20 (26.7)	19 (25.3)	36 (48.0)	
Very high/high	8 (20.5)	18 (46.2)	13 (33.3)	
No answer	3 (14.3)	10 (47.6)	8 (38.1)	
In general, how severe you think COVID-19 disease is?				0.813
Not at all serious/slightly serious	14 (16.5)	35 (41.2)	36 (42.4)	
Moderately serious	29 (14.5)	80 (40.0)	91 (45.5)	
Severely serious	18 (13.1)	50 (36.5)	69 (50.4)	
No answer	1 (25.0)	1 (25.0)	2 (50.0)	
Tested for COVID-19				0.112
Never tested	12 (18.8)	29 (45.3)	23 (35.9)	
Yes, negative	30 (16.8)	62 (39.2)	87 (48.6)	
Yes, positive	15 (9.8)	60 (39.2)	78 (51.0)	
No answer	5 (16.7)	15 (50.0)	10 (33.3)	
Have received at least 1 dose of COVID-19 vaccine				0.022
No	30 (20.8)	54 (37.5)	60 (41.7)	
Yes	31 (11.1)	111 (39.6)	138 (49.3)	
No answer	1 (50.0)	1 (50.00	0	

Chi-square test or Fisher exact test for categorical data; analysis of variance (ANOVA) for continuous data.
Levels of HFE were identified using hierarchical clustering analysis.

14% (51) of non-Hispanic participants, differences between ethnicities did not reach statistical significance (Table 3).

Regarding dispositional optimism, 82% (51) of participants with low HFE reported low level of optimism, but only 9.7% (19) of participants with high HFE reported high level of optimism ($p < .0001$). The CD-RISC2 scores were lower in the low HFE category compared to moderate and high HFE (mean (SD), 4.6 (1.7) vs 5.7 (1.4) vs 6.1 (1.5), $p < .0001$). Pearson correlation indicated that there was a significant positive and moderate correlation between HFE score and CD-RISC2 score ($r = 0.33$, $p < .0001$), and between HFE score and LOT-R score ($r = 0.37$, $p < .0001$).

Dispositional Optimism

The Revised Life Orientation Test (LOT-R) is a standard psychological instrument that assesses one's dispositional level of optimism. Higher scores indicate a more optimistic outlook. Levels of optimism are defined as low (scores between 0-13), moderate (14-18) and high (19-24). In our study, the mean (SD) LOT-R score was 13.2% (3.9), and 52.7% (225) of participants had low level of optimism, while 41.2% (175) and 6.1% (26) had moderate and high levels of optimism, respectively. Lower optimism (high pessimism) was observed among female participants compared to male participants (mean (SD), 13.0 (4.1) vs 13.9 (3.0), $p = 0.018$), LGBTQ+ (mean (SD), 11.3 (4.1) vs 14.0 (3.5), $p < .0001$), Agnostic/no religion participants compared to Christian participants (mean (SD) ,11.3 (3.9) vs 14.3 (3.5), $p < .0001$), current/former cigarette smokers compared to never smokers (mean (SD) 11.5 (4.5) vs 13.4 (3.8), $p = 0.009$), and among participants reporting fair/poor health compared to excellent/good health (9.8 (4.3) vs 13.8 (3.5), $p < .0001$) Table 4.

CD-RISC2 Resilience Scores

The CD-RISC 2 is based on items 1 and 8 (score range from 0-8) of the full 25-item CD-RISC and was developed as a measure of "bounce-back" and adaptability. In our sample, the mean (SD) CD-RISC2 score was 5.7 (1.6). Most demographic characteristics were associated with CD-RISC2 score (Table 5). Lower resilience mean scores were observed among minority groups. Significant mean differences were observed among Hispanic participants compared to non-Hispanic participants (4.8 vs 5.8, $p = 0.0199$), self-identified as LGBTQ+ compared to heterosexual (5.0 vs 5.9, $p < .0001$), and participants practicing another religion compared to Christianity and no religion (4.9 vs 5.4 vs 6.0, $p < .0001$). Lower mean resilience scores were also observed among female

Table 4. Revised Life Orientation Test (LOT-R) Scores by Demographic Characteristics, n=427

	mean (SD)	*p*
Age group (years)		0.279
16-17	12.9 (3.9)	
18-21	13.3 (3.6)	
Sex		0.018
Female	13.0 (4.1)	
Male	13.9 (3.0)	
Sexual orientation: LGBTQ+		<.0001
No	14.0 (3.5)	
Yes	11.3 (4.1)	
Race		0.342
Caucasian/White	13.4 (3.9)	
African American	13.4 (3.7)	
Other	12.5 (3.6)	
Ethnicity		0.409
Non-Hispanic	13.3 (3.9)	
Hispanic	12.6 (2.9)	
Participant educational level		0.113
High school or less	13.1 (3.9)	
Some college or higher	13.8 (3.9)	
Parent educational level		0.001
High school or less	12.4 (3.4)	
Some college or higher	13.6 (4.0)	
Religion		<.0001
No religion/Agnostic	11.3 (3.9)	
Christianity	14.3 (3.5)	
Other religion	13.3 (1.9)	
Cigarette smoker		0.009
Never	13.4 (3.8)	
Current smoker/former smoker	11.5 (4.5)	
E-cigarette user		0.068
Never	13.4 (3.7)	
Current user/former user	12.5 (4.2)	
General health		<.0001
Excellent/Very good/Good	13.8 (3.5)	
Fair/Poor	9.8 (4.3)	
Been told by a health care provider that I have a chronic disease		0.069
No	13.5 (3.9)	
Yes	12.7 (3.9)	

Analysis of variance (ANOVA) or t test p-values.

Table 5. Two-item Version Connor-Davidson Resilience Scale (CD-RISC2) Score by Demographic Characteristics, n=421

	mean (SD)	*p*
Age group (years)		0.341
16-17	5.6 (1.6)	
18-21	5.8 (1.6)	
Sex		0.029
Female	5.6 (1.7)	
Male	5.9 (1.4)	
Sexual orientation: LGBTQ+		<.0001
No	5.9 (1.5)	
Yes	5.0 (1.6)	
Race		0.055
Caucasian/White	5.8 (1.5)	
African American	5.8 (1.6)	
Other race	5.2 (1.8)	
Ethnicity		0.002
Non-Hispanic	5.8 (1.5)	
Hispanic	4.8 (1.9)	
Participant educational level		0.004
High school or less	5.6 (1.6)	
Some college or higher	6.2 (1.3)	
Parent educational level		<.0001
High school or less	5.1 (1.8)	
Some college or higher	6.0 (1.4)	
Religion		<.0001
No religion	5.4 (1.6)	
Christianity	6.0 (1.5)	
Other religion	4.9 (1.1)	
Cigarette smoker		0.006
Never	5.8 (1.5)	
Current smoker/former smoker	5.0 (1.9)	
E-cigarette user		0.048
Never	5.8 (1.5)	
Current user/former user	5.4 (1.7)	
General health		<.0001
Excellent/Very good/Good	5.9 (1.5)	
Fair/Poor	4.8 (1.5)	
Been told by a health care professional that I have a chronic disease		0.118
No	5.8 (1.6)	
Yes	5.5 (1.6)	

Chi-square test or Fisher exact test for categorical data; analysis of variance (ANOVA) for continuous data.

participants compared to male participants (5.6 vs 5.9, $p = 0.029$), and participants with lower educational level compared to some college or higher (5.6 vs 6.1, $p = 0.0016$). Lower resilience scores were also observed among cigarette smokers, e-cigarette users and nonsmokers, and among participants with fair/poor self-reported general health.

Linear Regression Analysis

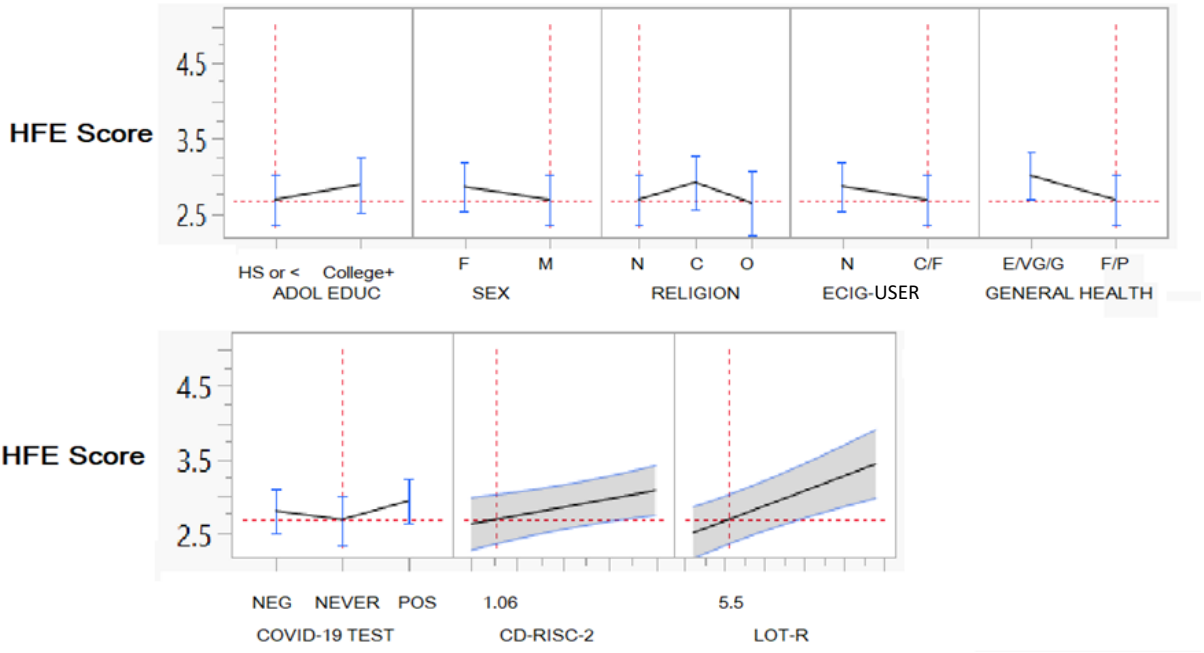
In the final multivariable linear regression model using HFE as continuous dependent variable, the results indicated there was a collective significant effect of sex, participant educational level, religion, general health, e-cigarette use, having had a COVID-19 test, CD-RISC score, and LOT-R score ($F(10, 342) = 13.63$, $p < .0001$, $AdjR^2 = 0.27$). The assumptions of homoscedasticity, independence of observations, and normality of residuals were met.

The profiler plot (Figure 1) shows the predicted response for 2 scenarios at specified values of each of the predictor variables, which are listed across the bottom of graphs. The bracketed values represent the 95% CI for the average HFE score at the values of the predictors. Scenario A displays the predicted mean HFE score of 2.7 (95% CI: 2.3; 3.0), for a male participant who has high school or less, is not associated with any religion, is former/current e-cigarette users, has fair/poor general health, CD-RISC score of 1.06, and LOT-R score of 5.5. In contrast, scenario B displays the predicted mean HFE score of 5.0 (95% CI: 4.9; 5.0] for a female participant with some college or higher education, who identified as Christian, never used e-cigarettes, has excellent/good general health, had a positive COVID-19 test, high CD-RISC score of 7.0, and high LOT-R score of 22.

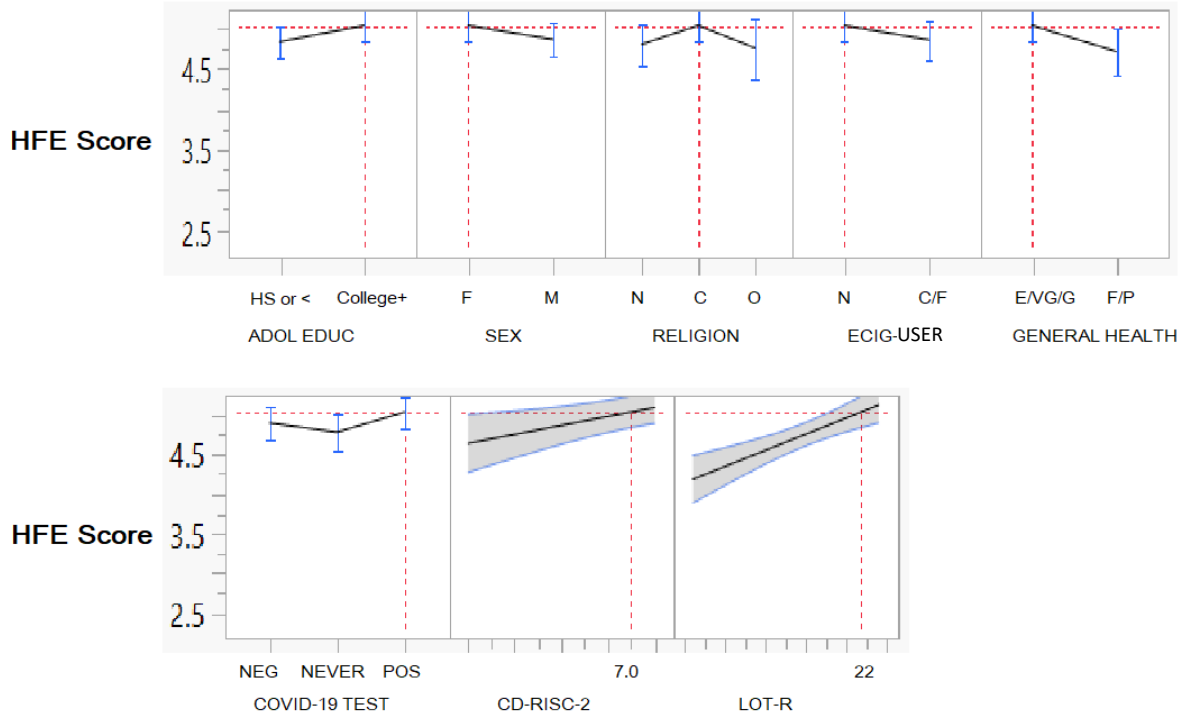
Participant Comments

At the end of the survey, participants had the opportunity to comment on any aspects of the COVID-19 pandemic that were not addressed in the survey. Some participants made general comments about the COVID-19 pandemic's impact on socialization and their political views. Several of the 32 comments were of strong feelings of disappointment with the public authorities and community on how they handled the pandemic. For instance, some said "countries and worlds [sic] response was awful and it should've been better." A total of 5 participants protested the mandatory

Scenar



Scenario B: HFE Score 5.0 [4.9; 5.0]



Abbreviations: HFE=hopeful future expectations; HS=high school; ADOL EDUC=participant educational level; RELIGION: N=no religion, O=other religion, C=Christian; ECIG-USER=e-cigarette user: NEG=negative, POS=positive; GENERAL HEALTH: F/P=fair or poor, E/VG/G=excellent/very good/good; CD-RISC2, 2-item version of Connor–Davidson Resilience Scale; LOT-R, Revised Life Orientation Test;

Figure 1. Linear Regression Model: Prediction Profiler Plot for Hopeful Future Expectations (HFE) Scenarios A and B

vaccination, 6 mentioned issues related to mental health, and 2 stated having their finances or work affected. But 1 comment stood out which may have summarized their experience: "I felt that my growing up was almost stopped…"

There is a small indication, however, that the experience of going through the COVID-19 pandemic resulted in some positive lessons. One stated that "I'm now able to accept change better and not take certain things for granted anymore," and another said the pandemic "has taught me other things about myself. For example, I've found enjoyment out of activities that I tried when quarantined and I became more independent and happier with myself." See Appendix for more comments from participants.

DISCUSSION

As we continue to improve our understanding of the consequences of a large health crisis on the lives of AYA as they make the transition to adulthood, this study provides insights regarding their HFE, resilience, and optimism during the COVID-19 pandemic. This significant public health emergency clearly represents one of the most intense and potentially life-changing events impacting today's adolescents. Indeed, fully 19% of our sample indicated that the pandemic very much or completely affected the way they perceived their future. While high HFE was observed among 39% of participants, difference in HFE scores was observed across most demographic characteristics. Lower levels of HFE were observed among participants who self-identified as LGBTQ+ and Hispanic participants. However, the effects of these demographic factors on HFE were not significant in the presence of other factors in the regression model. The regression results indicated that there was a collective significant effect of sex, participant educational level, religion, general health, e-cigarette use, having had a COVID-19 test, resilience, and optimism scores. It may be that, since LGBTQ+ participants and Hispanic participants showed lower resilience and optimism levels, the presence of resilience and optimism scores in the regression model may have overpowered the effect of these demographic factors on HFE, especially considering the low number of Hispanic participants.

In our sample, the mean HFE (4.1) was lower compared to that found in samples of eighth grade students (4.46) generally.[10] This difference may be in part attributed to their natural development as they enter adulthood, with decreasing HFE in the later high school years and into early adulthood. However, in our study, the difference in HFE between groups of participants aged 16-17 years and aged 18-21 years was not significant. The results observed in this study may be the consequence of the widespread school and workplace closures affecting young people and their families, as well as worries related to their future, their health and that of family and loved ones.

The observed low mean LOT-R of 13.2 indicates high pessimism among our study participants, and an observed moderate mean CD-RISC2 of 5.7 reflects their resilience. Low mean dispositional optimism scores and low resilience scores were found among LGBTQ+ individuals. Although no significant differences in optimism and resilience were observed between races, Hispanic individuals reported significantly lower resilience than non-Hispanic individuals. Because optimism and resilience may serve as a protective factor against suicidality among Latino American[25] and LGBTQ+ individuals,[24] schools, colleges, and health professionals should pay special attention to individuals who belong to minority groups. Other groups that could benefit from some attention could be those with no religion or professing a religion other than Christianity, cigarette smokers, and those reporting fair/poor general health. These groups also reported low resilience and optimism in our sample.

Limitations

Our findings provide estimates of HFE, LOT-R, and CD-RISC2 and identify valuable new insights into the complex processes that contribute to the effect of a pandemic on the HFE of AYA. However, the findings of the present study should be interpreted carefully considering the limitations of this research. This cross-sectional study collected data 2 years after the World Health Organization declared the COVID-19 pandemic. At that time, schools and colleges had resumed their activities and the HFE, resilience, and optimism scores may have been lower during the lockdown period. Regardless, the estimates of HFE, LOT-R, and CD-RISC2 in our sample are a concern, as the literature indicates these measures are associated with risk behaviors among youth. Research has suggested aspirations requiring high levels of education are associated with decreased odds of alcohol and substance use.[12] Although future expectations were not measured, in a survey of Israeli youth aged 15-18 years during the lockdowns in 2020, more than 20% of participants started to or increased their frequency of smoking cigarettes (20.7%), smoking e-cigarettes (27.4%), and smoking cannabis (30.6%).[44] In Canada, a survey of teens aged 16-18 years in 2020 found an increase in the use of alcohol and cannabis.[45]

Some bias might be implied due to the low number of African American participants and members of other minority groups in this sample. It is possible that people in other race categories than Caucasian/White and African American, for instance, would have different responses to the COVID-19 pandemic. Small sample sizes were available for these groups; therefore, their data were aggregated in the other/multiple race category. Aggregated racial and ethnic data might obscure differences in coverage that are apparent in disaggregated subgroups.

Moreover, we acknowledge that population-based studies are not inherently protected from bias; individuals sampled from the hospital patient population, who are seeking services, may consent or refuse to participate in research, and their willingness to participate is unlikely to be random. To ameliorate that, we included any visit to hospital sites and departments, including emergency departments, dental, and all types of visits. Finally, there was a

potential for selection bias if the participation in an online survey is indicative of higher engagement and stronger opinions about the COVID-19 pandemic and/or vaccines in general.

This study was rigorously and carefully designed and conducted to ensure internal validity. Whether or not the internally valid results of this study can be then broadly generalized to other study settings, samples, or populations is a matter of judgment of the relevant findings.[46] This study was designed to be representative of AYA in the Ohio population. However, this approach could have limited the ability to discover opportunities in underserved communities and minorities, both due to an online panel as well as potential language limitations. Focused studies in particular areas and demographics of interest would better suit an analysis of differences within a group or region.

Future Directions

Research examining factors associated with HFE has been limited among AYA. Our findings may have several implications for future research and interventions aiming to improve HFE, which consequently may reduce risky behavior among adolescents, improve their transition to adulthood, and foster a healthy adult life.

Future work should be performed to cross-validate these findings in other populations of AYA. It is possible that cultural differences with respect to parenting and future orientation, participation in sport activities, mentorship, and social engagement in the local community would yield different levels of HFE. More research using a larger general adolescent population and a longitudinal approach would be necessary for a greater understanding of how HFE may influence adolescent transition to adulthood and how these associations may differ by demographic characteristics.

A common starting point for future research would be the acknowledgment of the importance of collecting demographic data from AYA in clinical settings, considering that minority AYA may be exposed to greater frequency and severity of hardships—violence, poverty, hate crimes, family dynamics—compared with their majority same-age peers. Our unique findings among minorities may encourage future research opportunities for investigating and building stronger HFE among AYA.

PUBLIC HEALTH IMPLICATIONS

Reflecting on research that has highlighted the important role of HFE and optimism on the physical and mental health of AYA and that consequently may improve their adult health, this study reinforces suggestions that the development of early interventional programs and the configuration of clinical and public health practices provided to AYA, especially individuals who belong to minority groups, be prioritized in future crises in an effort to facilitate effective life transitions, including passage to college and eventual adulthood.

CONFLICTS OF INTEREST

The authors have no relevant financial or nonfinancial interests to disclose.

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Statements

The data used during the current study are available from the corresponding author on reasonable request. The authors declare that they have no competing interests. This research project was funded by the Akron Children's Foundation Grant (Grant number #4500086). This study received ethical approval from the Akron Children's Hospital institutional review board (approval no. 2021-058).

Authors have no conflict of interest to disclose.

AUTHOR CONTRIBUTION

Miraides F. Brown: conceptualization, methodology, acquisition of funding, writing–original draft preparation, data analysis and interpretation of the data, review and editing, and approval of the final version of the manuscript. Vinay K. Cheruvu, Jonathan B. VanGeest, Tarah Smith, Diane L. Langkamp: substantial contributions to design, interpretation of data, substantial contributions to acquisition of funding, critical review of the manuscript for important intellectual content, review and editing, and approval of the final version of the manuscript. Nao Mimoto: interpretation of data, critical review of the manuscript for important intellectual content; review and editing; and approval of the final version of the manuscript.

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APPENDIX—Final Comments of Participants About COVID-19 Pandemic

Please note: The following participant responses are presented verbatim and have not been edited for grammar or spelling.

- "A lot of people's lives were upended during the pandemic, and it was really difficult on my family financially."
- "I couldn't work because of covid cases."
- "We put so many peoples lives on the line medical personable and mandatory workers specifically my mom is an X-ray Tech n everyday we weren't sure if she'd get sick she has multiple preexisting conditions too luckily she was ok, but some people weren't I'm sorry to everyone who lost a loved one and I'm sad that our culture hasn't shifted to be cleaner as a result of the pandemic."
- "Almost everyone my age I know has some sort of depression or anxiety or lack of hope for the future directly related to Covid and how insecure our generations future is"
- "I felt that my growing up was almost stopped by the pandemic unable to attend school and see friends stoped me from building a healthy and social life style and I am just know recovering it."
- "Mental illnesses worsened with Covid-19"
- "Fear of not socializing normal in the future like next year for senior year or even college"
- "It sucked and the country's and worlds response was awful and it should've been better"
- "It's shown me who the people are who don't care about others"
- "Its stressful when it feels like the adults in charge are just as clueless as you when it comes to making life normal again."
- "The world had a complete over reaction"
- "We need a new President"
- "after adapting to the pandemic, I believe I'm now able to accept change better and not take certain things for granted anymore."
- "I think that aside from the downfalls of the pandemic it has taught me other things about myself. For example I've found enjoyment out o activities that I tried when quarantined and I became more independent and happy with myself."
- "Covid made me never have a prom"
- "my junior and senior year of high school wasn't the way it should have been - I missed out on sports and dances and fun. plus, my freshman year of college was not a normal experience. I hope it gets better in the fall for my sophomore year."
- "did not attend in class high school for 1 and a half years, this was ca terrible time for me because I just got diagnosed with type 1 diabetes the week before classes ended because of covid."
- "Government, employers and should NOT be allowed to force us to get any vaccine or we lose our jobs, etc."
- "I've never been a fan of shots and more now than ever. The conducted a vaccine that we had just encountered and had a vaccine approved to be used within less than a year. Mind you, covid was created by a person."
- "Live Normal. Do not make the vaccine mandatory. Use common sense, just like you would not visit family with the flu, same applies with the virus."
- "Should our government or employers be allowed to force us get vaccinated or lose our jobs? NO!"
- "The covid 19 vaccine is not a "typical" vaccine, it's a new kind, so I'd rather wait a few years to see if anyone has any side effects. Plus, since people are still testing positive for covid being fully vaccinated, there's no point in getting anymore. In order to keep up with the virus variants, they're going to have to continue making more and more boosters which is just not going to be efficient."
- "Me and most of my circle of friends would die if we caught COVID. I try so hard to keep us all safe because I'm the only one who can get vaccinated."
- "I forgot to mention body aches on the list of common symptoms for Covid. I feel like I'm less likely to get it than my peers because I mask indoors. The only reason I did this was for the Amazon gift card I got sent in the mail. I hope it's five dollars or more."
- "I respect everybody's decisions on how they handle this pandemic, these are just my personal feelings"
- "It sucks"
- "It suck's"
- "It was bad"
- "Nothing to share"
- "Thank you"
- "With the pandemic hopefully coming to a close, this questionnaire was extremely thoughtful to the concerns of young adults and I was glad to help."
- "nothing :)"

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RESEARCH BRIEF

Resilience and Mental Health in Southwest Ohio During the COVID-19 Pandemic

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ABSTRACT

Background: During the COVID-19 pandemic, anxiety and depression rates spiked across the United States and continued to climb after August 2020. Research from the early months of the COVID-19 pandemic suggests that resilience and meaning-and-purpose were associated with positive mental health outcomes in this context. Little is understood about how this association persists after more than 5 months of ongoing disaster exposure, as was the case for the COVID-19 pandemic. The goal was to examine this relationship in adults in Southwest Ohio.

Methods: Resilience, meaning-and-purpose, anxiety, and depression symptom surveys were completed electronically from August 1, 2020, to November 30, 2020. Regression analyses examined relationships between these factors and sociodemographic variables.

Results: Participants (N=98) reported anxiety and depression in mild ranges. Age was negatively associated with anxiety ($p=.03$). Meaning-and-purpose was negatively associated with both anxiety ($p=.002$) and depression ($p<.001$). Resilience was negatively associated with depression ($p=.001$). Further, reporting a mental health condition moderated the relationship between resilience and anxiety ($p=.03$), such that higher resilience was associated with higher anxiety in individuals reporting a mental health condition.

Conclusion: Our study found associations between anxiety and depression symptoms and meaning-and-purpose. Our study also found associations between anxiety and depression symptoms and resilience. The moderated relationship between resilience and anxiety symptoms supports the importance of assessing mental health status, particularly during public health emergencies. Regardless of mental health status, higher meaning-and-purpose was associated with lower anxiety and depression. Additional research is needed to better understand the role of meaning-and-purpose and resilience during future public health challenges.

Keywords: Brief Resilience Scale; Meaning and purpose; COVID-19 pandemic; Disaster; Mental health

INTRODUCTION

Consistent with previous epidemics,[1–3] the COVID-19 pandemic had a major impact on adult mental health across the United States (US).[4] From April 2020 to December 2020, clinically significant anxiety and depression was present in 31.5% to 45.8% and 21.8% to 39.0% of adults, respectively.[5–8] This was a dramatic increase from previous 12-month estimates for generalized anxiety disorder and major depressive episodes (2.9% and 9.3%, respectively).[5,9] National and state trends demonstrated a continual rise of reported depression and anxiety symptoms peaking in December 2020 to January 2021.[10,11] In Ohio, increases in the severity of anxiety and depression scores between August 2020 and December 2020 averaged 1.5% and 1.8%, respectively.[10] One longitudinal study using data from the Ohio Medicaid Assessment Survey, found the prevalence of mental health impairment (MHI), a severe indicator of disruption in functioning, rose to 8.2% in 2021, compared with 7.5% in 2019. Increases in MHI during that year were steepest for Black adults, females, and those aged 19 to 24 years.[12]

A much smaller body of research has explored how strengths-based factors—characteristics, including resilience and meaning and purpose, indicative of effective psychological coping with stressful events—are impacted. Resilience, the ability to "bounce back" from stressful events without prolonged disruptions in functioning, has been found to be the most common psychological response to the stress of disasters.[13,14] In a recent study during the COVID-19 pandemic, Wong et al[15] found 72.8% of a global sample reported normal-to-high levels of resilience using the Brief Resilience Scale (BRS), whereas in the Americas and Europe this was reported in only 63.6% of the population. Factors related to resilience in a disaster include older age and social support.[4,15–18] Pre-COVID-19-pandemic resilience has been associated with lower COVID-19-related anxiety and depression.[19,20] In one study of 1270 older adults (aged 55 years and older), resilience was associated with better mental health outcomes at 5 subsequent timepoints between April 2020 and June 2020.[21] Meaning and purpose (meaning-and-purpose), the degree to which a person feels their life has meaning, purpose, fulfillment, and a sense of direction, has been associated with better mental health outcomes following stressful events,[22] and was found to be a latent protective factor for developing depression symptoms during the pandemic.[23]

Much of the data investigating associations between resilience, meaning-and-purpose, and mental health were collected during the first few months of the pandemic; little is known about the relationship of these factors specifically in Ohio. Disaster-exposures typically are not prolonged, with resilience and decreases in psychological symptoms observed within 1-6 months following exposure.[13,14,16,24] However, in the case of the COVID-19 pandemic, estimates of anxiety and depression continued to rise nationally as well as in Ohio more than 5 months following the US emergency declaration.[10] It is unclear whether associations between resilience, meaning-and-purpose, and mental health would remain after 5 or more months of continuous disaster exposure, prior to effective treatments or vaccines, and while emergency governmental supports were expiring.[11,25,26]

The aim of the current study is to examine the relationship between strengths-based psychological factors (resilience and meaning-and-purpose) and anxiety and depression symptoms in a sample of Southwestern Ohio adults, 5 to 8 months following the COVID-19 emergency declaration in the US[11] (August–November, 2020). We hypothesized that resilience[17,19,21,27,28] and meaning-and-purpose[22,23,29,30] would have a significant, negative association with anxiety and depression symptoms beyond relevant sociodemographics, such as age, gender, racial/ethnic identity, self-reported mental health condition, and neighborhood distress.[4,15–18] We also hypothesized that these associations would be moderated by self-report of a preexisting mental health condition.[17,19,27,31]

METHODS

Data from the current study come from a larger prospective cohort study conducted during the COVID-19 pandemic by Hood and colleagues[32] with cohorts in the US, United Kingdom (UK), and Mexico. The use of multiple cohorts was intended to enable analysis of differing attitudes toward COVID-19, helping to gauge health policy effectiveness and public perception. Participants completed mental health and strengths-based measures monthly, and poll questions daily about the COVID-19 pandemic (eg, did you have difficulty following masking recommendations today?). The current study uses data (anxiety, depression, resilience, and meaning-and-purpose measures) from the US cohort collected August to November 2020.

Participants

Participants were recruited via flyers, cultural brokers, social media, websites, word of mouth and local agencies serving Black and Latine/Hispanic populations. The goal was to have demographics that reflected the major metropolitan municipality in the region (ie, Cincinnati, Ohio; targets 41% Black and 4% Latine/Hispanic, respectively).[33] Participants were eligible if they were age 18 years and older, US residents, could read in English or Spanish, and had access to a phone, computer/ tablet to complete measures electronically. A convenience sample was recruited among adults who lived or worked in Cincinnati, Ohio, and included those with residences across the tri-state (Ohio-Kentucky-Indiana). All participants reviewed the informed consent form and provided their electronic signature before completing study measures. The cohort study was reviewed and found to be exempt by the Cincinnati Children's Hospital Medical Center's institutional review board.

Measures

Baseline sociodemographic data included age, gender, race/ethnicity, relationship status, education, employment, essential worker status, and caregiver status. Self-reported, preexisting mental health condition (*mental health condition* hereafter) was collected as a yes-no question. Measures included in the analyses for the present study were the Patient-Reported Outcomes Measurement Information System (PROMIS) Short Form Anxiety v1.0 (7a),[34] Patient Health Questionnaire-9 (PHQ-9),[35,36] Brief Resilience Scale (BRS),[28] and PROMIS Short Form Meaning and Purpose v1.0 (4a).[37] Distressed Communities Index (DCI) scores were assigned based on zip code.[38] Participant characteristics are shown in Table 1.

Table 1. Participant Characteristics (n=98)[a-e]

Characteristic	Value		Characteristic	Value
Age in years (18-73, *n*=96), *M*(SD)	46.24 (14.07)		**County area, *n*(%)**	
Racial/Ethnic identity, *n*(%)			Cincinnati Metro	88 (89.8)
Asian	1 (1)		Other	4 (4.1)
Black, Non-Hispanic	46 (46.9)		Missing	6 (6.1)
Latine/Latinx/Hispanic	7 (7.1)		**State, *n*(%)**	
White, Non-Hispanic	39 (39.8)		Ohio	81 (82.7)
Mixed/Multiple groups	3 (3.1)		Kentucky	10 (10.2)
Missing	2 (2)		Indiana	1 (1)
Gender identity, *n*(%)			Missing	6 (6.1)
Female	73 (74.5)		**Caregiver status, *n*(%)**	**30 (30.6)**
Male	23 (23.5)		Parent	28 (28.6)
Missing	2 (2)		Grandparent	1 (1)
Distressed Communities Index (DCI) quintile, *n*(%)			Other	1 (1)
1-Resourced	23 (23.5)		**Relationship status, *n*(%)**	
2	15 (15.3)		In a relationship	19 (19.4)
3	15 (15.3)		Married	44 (44.9)
4	22 (22.4)		Single	32 (32.7)
5-Distressed	17 (17.3)		Widowed	1 (1)
Missing	6 (6.1)		Missing	2 (2)
Mental health condition (MHC), *n*(%)			**Education, *n*(%)**	
Yes	15 (15.3)		< High school	2 (2)
No	80 (81.6)		High school	7 (7.1)
Prefer not to say	1 (1)		Some college	19 (19.4)
Missing	2 (2)		College graduate	35 (35.7)
			Post graduate degree	33 (33.7)
Measure scores	***n***	***M*(SD)**	Missing	2 (2)
Patient Reported Outcome Measurement System (PROMIS) anxiety	**93**	**55.29 (9.47)**	**Employment status, *n*(%)**	
Mental health condition	14	63.80 (9.35)	Employed	72 (73.5)
No mental health condition	79	53.79 (8.72)	Unemployed	7 (7.1)
Patient health questionnaire-9 (PHQ-9)[c]	**92**	**5.34 (5.14)**	Disabled	2 (2)
Mental health condition.	14	11.00 (6.39)	Retired	5 (5.1)
No mental health condition	78	4.33 (4.22)	Homemaker	3 (3.1)
Brief Resilience Scale[d]	**93**	**3.72 (0.81)**	Student	1 (1)
Mental health condition	14	3.00 (1.08)	Other	2 (2)
No mental health condition	79	3.84 (0.69)	Missing	6 (6.1)
PROMIS meaning and purpose	**94**	**55.20 (10.34)**	**Essential worker, *n*(%)**	
Mental health condition	14	45.94 (13.90)	Yes	40 (40.8)
No mental health condition	80	56.82 (8.74)	No	37 (37.8)
			Missing	21 (21.4)

[a] Table 1 includes the total number in each group followed by the percentage in each group in parentheses for categorical variables. Age and Measure Scores are presented as mean (standard deviation). PROMIS = Patient Reported Outcomes Measurement Information System. DCI = Distressed Communities Index. Mental Health Condition = self-reported, preexisting mental health condition.
[b] PROMIS Anxiety Scoring[34]: Less than 55=None to slight; 55.0-59.9=Mild; 60.0-69.9=Moderate; 70 and over=Severe. Total: *n*=93; Mental Health Condition, *n*=14; No Mental Health Condition, *n*=79. Test for significant difference: Mental Health Condition mean was significantly higher, $t_{17.89}$=3.73, *p*=.002; 95%CI 4.37, 15.65.
[c] PHQ-9 Scoring[35,36]: 0-4=None; 5-9=Mild; 10-14=Moderate; 15-19=Moderately Severe; 20-27=Severe. Total: n=92; Mental Health Condition, n=14; No Mental Health Condition, *n*=78. Test for significant difference: Mental Health Condition mean was significantly higher, $t_{15.42}$=-3.76, *p*=.002; 95%CI -10.43, -2.90.
[d] Brief Resilience Scale Scoring[28]: Range 1-5; higher scores indicate greater resilience. Total: *n*=93; Mental Health Condition, *n*=14; No Mental Health Condition, *n*=79. Test for significant difference: Mental Health Condition mean was significantly lower, $t_{15.23}$=2.82, *p*=.01; 95%CI 0.21, 1.48.
[e] PROMIS Meaning and Purpose Scoring[37]: The United States M(SD)=50(10); higher scores indicate greater meaning and purpose. Total: *n*=94; Mental Health Condition, *n*=14; No Mental Health Condition, *n*=80. Test for significant difference: Mental Health Condition mean was significantly lower, $t_{15.13}$=2.83, *p*=.01; 95%CI 2.69, 19.06.

Data Analysis

Descriptive statistics were computed for all demographic variables as well as the primary outcome variables. To test the hypothesis that resilience and meaning-and-purpose would have a significant, negative association with anxiety and depression, and that the associations between anxiety or depression and resilience and meaning-and-purpose would be moderated by whether or not the participant reported a mental health condition, we conducted several linear regression models:

Model 1a. PROMIS anxiety scores were the outcome and the primary predictors were PROMIS meaning-and-purpose and BRS scores, with age, DCI, gender, race/ethnicity, and mental health condition as covariates.
Model 1b. Same as 1a, with a moderation of BRS scores by mental health condition added.
Model 1c. Same as 1a, with a moderation of PROMIS meaning-and-purpose scores by mental health condition added.
Model 2a. PHQ-9 scores as the outcome and the primary predictors were PROMIS meaning-and-purpose scores and BRS scores, with age, DCI, gender, race/ethnicity, and mental health condition as covariates in the model.
Model 2b. Same as 2a, with a moderation of BRS scores by mental health condition added.
Model 2c. Same as 2a, with a moderation of PROMIS meaning-and-purpose scores by mental health condition added.

All analyses were conducted in Stata, Version 18.[39] Multiple imputation in Stata with 100 imputed datasets was used to address intermittent missing data, assumed to be missing at random.

RESULTS

Participant Characteristics

The participants *(N*=98) were from the tri-state region of Ohio, *n*=81(82.7%), Kentucky, *n*=10(10.2%), and Indiana, *n*=1(1%), with most residing in the Greater Cincinnati Metro area, *n*=88 (89.8%). The majority identified as female, *n*=73(74.5%), and reported their racial/ethnic identity as Asian, *n*=1(1%), Black, *n*=46(46.9%), Latine/Hispanic, *n*=7(7.1%), White, *n*=39(39.8%), and Mixed/Multiple, *n*=3(3.1%). Most reported employment, *n*=72(73.5%), and nearly half, *n*=44(44.9%), reported being married. There was representation from all 5 quintiles in the distribution of community distress. See Table 1.

Overall, participants' (*n*=93) average PROMIS anxiety scores fell in the mild range, *M*(SD)=55.29(9.47). Those reporting a mental health condition (*n*=14) had a mean anxiety score in the moderate range, *M*(SD)=63.80(9.35)—significantly higher than that of those without a mental health condition *n*=79, *M*(SD)=53.79 (8.72); $t_{17.89}$=3.73, *p*=.002; 95%CI 4.37, 15.65.

On average, participants (*n*=92) reported PHQ-9 depression scores in the mild range, *M*(SD)=5.34(5.14). Those reporting a mental health condition (*n*=14) had a mean PHQ-9 in the moderate range, *M*(SD)=11.00(6.39)—significantly higher than that of those without a mental health condition, *n*=78, *M*(SD)=4.33 (4.22); $t_{15.42}$=-3.76, *p*=.002; 95%CI -10.43, -2.90. Table 1 shows psychometrics.

Regression and Moderation Analyses

In Model 1a analyses, Age, *M*(SD)=46.24(14.07), was significantly, negatively associated with anxiety, *b*=-0.15, *p*=.03, 95%CI=-0.28, -0.01; no other sociodemographic variables were significant predictors. Meaning-and-purpose, *M*(SD)=55.20(10.34), was significantly, negatively associated with anxiety, *b*=-0.29, *p*=.002, 95% CI=-0.46, -0.11. Resilience, *M*(SD)=3.72(0.81), was not significantly associated with anxiety (see Appendix).

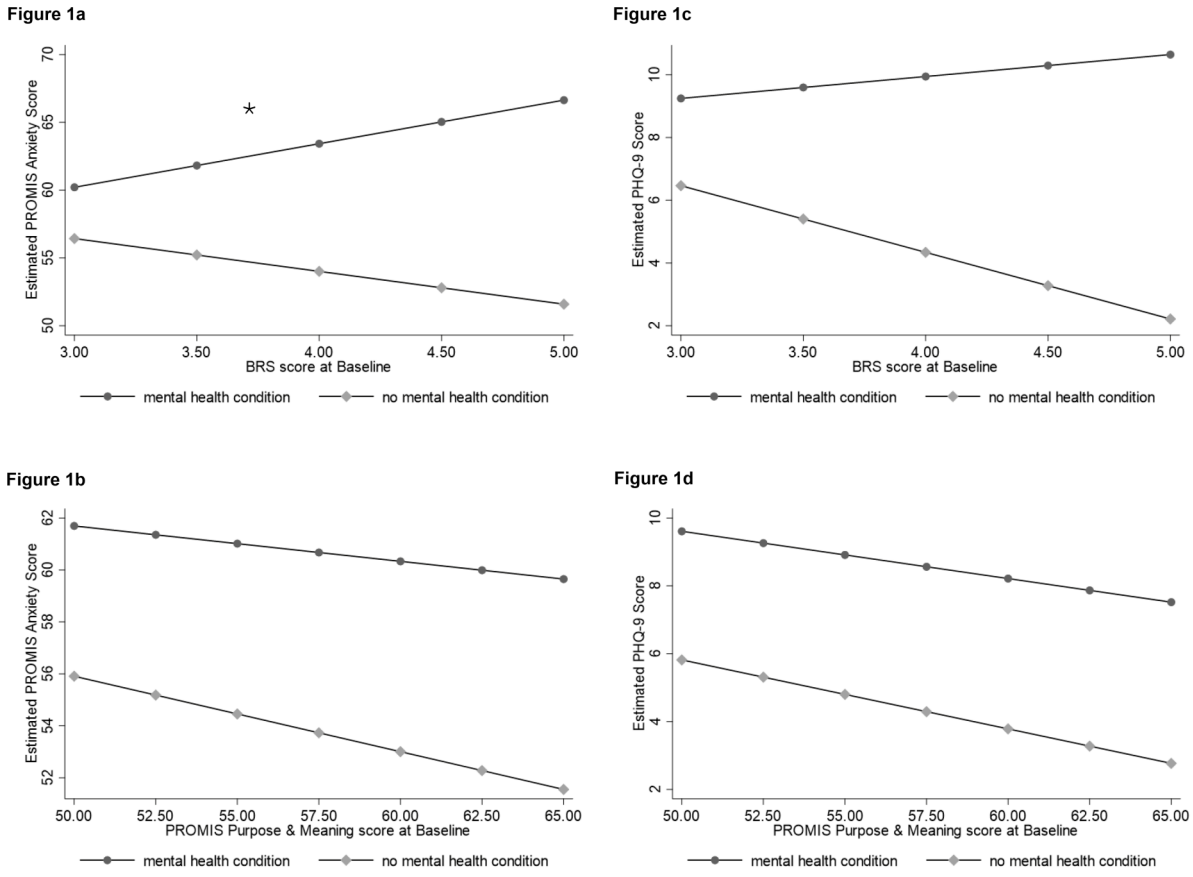
Model 1b, testing the moderation between resilience and mental health condition, was significant for anxiety, *b*=5.16, *p*=.03, 95% CI=0.39, 9.94, such that when a mental health condition was *not* reported, higher resilience was associated with lower anxiety, whereas when a mental health condition *was* reported, higher resilience was associated with higher anxiety. In Model 1c, the moderation for meaning-and-purpose was not significant (Figure 1; see also Appendix).

In Model 2a analyses, sociodemographic variables were not significantly associated with depression scores. Meaning-and-purpose, *b*=-0.21, *p*<.001, 95%CI=-0.29, -0.13, and resilience, *b*=-2.09, *p*=.001, 95%CI=-3.34, -0.84 were both significantly, negatively associated with depression. Model 2b moderation analyses were not significant (Figure 1; see also Appendix). In Model 2c analyses, the moderation for meaning-and-purpose was not significant.

DISCUSSION

The current study assessed associations between the strengths-based factors of resilience and meaning-and-purpose, and anxiety and depression in Southwestern Ohio adults 5 to 8 months into the COVID-19 emergency in the US. Consistent with data collected during the first few months of the pandemic,[23] having a higher sense of meaning-and-purpose was significantly associated with lower depression. Our study additionally found an association between higher meaning-and-purpose and lower anxiety. These associations rose to significance over and above relevant sociodemographic variables, except for age, where younger age predicted higher anxiety.

Similar to meaning-and-purpose, higher resilience was associated with lower depression. Resilience was also associated with lower anxiety, however this was dependent upon whether a mental health condition was reported. For those *without* a mental health condition, higher resilience was associated with lower anxiety as expected. For those *with* a mental health condition, higher resilience was associated with higher anxiety. At the same time, resilience was lower overall in participants with a mental health condition, compared to those without.



* Denotes a significant moderation effect.
[a] Figure 1 depicts self-reported mental health condition as a moderator between resilience or meaning-and-purpose and mental health outcomes (depression and anxiety symptoms): Top row (a, c) depicts moderation between resilience and mental health scores; bottom row (b, d) depicts moderation between meaning-and-purpose and mental health scores; left-hand column (a, b) depicts moderation with PROMIS anxiety scores; right hand column (c, d) depicts moderation with PHQ-9 depression scores. Graphs were made using Stata.

Figure 1. Graphed Moderations

Studies of COVID-19 indicate that higher-than-normal anxiety and depression symptoms persisted well into this prolonged disaster.[6,12,40] It is possible that those with a mental health condition may have a different experience during a disaster with respect to anxiety and depression. For example, Castellvi and colleagues found significant differences in resilience during the pandemic based on mental health condition status (ie, none, incidence, persistence, recovering), such that those experiencing a persistent mental health condition reported lower resilience.[27] It could be that those with a mental health condition require additional supports to foster resilience whereas those without are able to reap more benefits from an internal sense of resilience. Additional research is needed to understand this relationship, especially in the context of long-term disaster exposures (eg, a global pandemic).

Limitations and Future Directions

This study has several limitations. Although virtual survey collection allowed participation from a geographic area larger than Cincinnati, Ohio, a small sample size limits generalizability. This sample included high proportions of Black and Latine/Hispanic participants exceeding the percentages for Cincinnati residents, however, the sample included fewer members of other racialized groups.[33] Finally, the cross-sectional nature of the study limits the ability to draw inferences over time. Future studies with longitudinal data are needed given the potential that resilience interventions might be beneficial (Chen and Bonanno[41]).

Conclusion

The current study found that 5 to 8 months into the COVID-19 emergency, regardless of mental health condition, higher meaning-and-purpose was associated with lower anxiety and depression. Higher resilience was also associated with lower depression; however higher resilience was only associated with lower anxiety in those without a mental health condition. The only sociodemographic variable to show a significant association with mental health symptoms was age, with younger age predicting higher anxiety. Taken together, in situations of prolonged disaster, meaning-and-purpose, resilience, and the presence of a preexisting mental health condition may be effective targets for intervention in Southwest Ohioans.

PUBLIC HEALTH IMPLICATIONS

Emphasizing meaning-and-purpose during disasters may improve management of symptoms and well-being. This study

demonstrates that embedding meaning-and-purpose and resilience strategies into public health messaging and communications (eg, town halls) during prolonged periods of disaster uncertainty may be beneficial.

CONFLICTS OF INTEREST

The authors report no conflicts of interest.

AUTHOR CONTRIBUTION

All authors made substantial contributions to the conception or design of the work or the acquisition, analysis, or interpretation of data for the work, contributed to drafting the work or revising it critically for important intellectual content, gave final approval of the version to be published, and agreed 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.

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APPENDIX

Regressions Predicting Anxiety and Depression (N=98)[a-c]				
	Coefficient	SE	*p*	95%CI
Anxiety predictors				
Variable (Model 1a)[a-c]				
Gender	0.12	2.03	.95	-3.92, 4.16
Race	0.43	1.95	.83	-3.45, 4.32
Age	*-0.15**	*0.07*	*.03*	*-0.28, -0.01*
Distressed Communities Index (DCI)	-0.07	1.93	.97	-3.90, 3.77
Mental Health Condition (MHC)	-11.30	8.50	.19	-28.21, 5.62
Meaning and Purpose (M&P)	*-0.29***	*0.09*	*.002*	*-0.46, -0.11*
Resilience	-2.22	1.36	.11	-4.93, 0.48
Moderation[c]				
Resilience x MHC (Model 1b)	*5.16**	*2.40*	*.03*	*0.39, 9.94*
M&P x MHC (Model 1c)	0.14	0.21	.51	-0.27, 0.55
Depression predictors				
Variable (Model 2a)[a-c]				
Gender	-0.81	1.05	.44	-2.90, 1.28
Race	-0.84	0.92	.37	-2.67, 1.00
Age	-0.02	0.03	.60	-0.08, 0.05
Distressed Communities Index	-0.19	0.83	.82	-1.85, 1.46
Mental Health Condition. (MHC)	-5.13	5.63	.37	-16.34, 6.08
Meaning and Purpose (M&P)	*-0.21****	*0.04*	*<.001*	*-0.29, -0.13*
Resilience	*-2.09***	*0.63*	*.001*	*-3.34, -0.84*
Moderation[c]				
Resilience x MHC (Model 2b)	2.68	1.99	.18	-1.28, 6.65
M&P x MHC (Model 2c)	0.07	0.14	.62	-0.20, 0.34

*$p < .05$, **$p < .01$, ***$p < .001$

[a] DCI=Distressed Communities Index. Mental health condition (MHC)=self-reported, preexisting mental health condition. Significant associations are italicised with asterisks.

[b] Gender is dichotomized female/male. Race is dichotomized White/Black. DCI is dichotomized categories 1-3 and 4-5. MHC is dichotomized yes/no whether someone has reported a preexisting mental health condition. Significant predictors: Anxiety (Age, M&P, and Resilience x MHC Moderation); Depression (M&P, and Resilience). Prediction trend, but nonsignificant: Anxiety (Resilience, and MHC); Depression (Resilience x MHC Moderation).

[c] Model 1 is inclusive of all predictors and a Resilience x MHC moderation effect (significant for anxiety; similar, but nonsignificant, trend for depression). Model 2 is inclusive of all predictors and a M&P x MHC moderation effect (nonsignificant for both anxiety and depression).

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STUDENT REFLECTION

From Theory to Practice: An Epidemiology Student's Reflection on Navigating Observational Research Biases and Pitfalls for Trustworthy Science

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Observational epidemiology examines the distribution and determinants of disease in human populations without an investigator *administering* an intervention.[1] Unlike experimental studies, such as randomized controlled trials, where participants are randomly assigned to groups to assess treatment effectiveness by an investigator, observational studies are necessary when administering an exposure would be impractical or unethical.[2] However, epidemiologists increasingly recognize the need for rigorous methodologies and careful interpretation to enhance the quality and clinical relevancy of observational research.[3–5] While no study is free from error or bias, we must acknowledge limitations and build upon previous research. As a PhD candidate in epidemiology using observational data for my dissertation, I often reflect on the challenges of study design and biases that could influence my findings, striving to uphold the integrity of my research.

From my first day as a graduate student, I learned the importance of identifying and mitigating biases in epidemiologic study design. Initially, these concepts felt theoretical; something to memorize. However, as I progressed, they became tangible challenges that shaped my ability to critically evaluate data sources and analytical methods. A wise instructor once told my class that each data point represents a real-life experience. This idea may seem obvious, but working with large, complex data sets made it easy to lose sight of the human narratives behind the numbers. I knew I wasn't alone in this realization when, at the most recent Society for Epidemiologic Research annual meeting, the opening speaker replaced traditional unique identifiers with labels such as "Real Person #1, #2, etc." This simple yet profound visual served as a reminder of our ethical responsibility as researchers: to ensure our findings honor the lived experiences of the populations we study.

Throughout graduate school, I have focused on understanding and addressing the harmful effects of flawed study designs, inappropriate statistical methods, and various forms of bias. These issues not only compromise individual studies but also contribute to conflicting scientific evidence, which can erode public trust in research and hinder progress in public health. Additionally, the emphasis on quantitative methods may cause researchers to overlook the human stories behind the data. Incorporating qualitative and mixed-methods approaches offers a valuable opportunity to uncover biases in quantitative research and build stronger connections with the communities being studied.

Consider my research population, whose exposure to environmental contamination was explored in a phenomenological study published in a previous Ohio Journal of Public Health issue.[6] Using transcribed interviews from the Fernald Living History Project, recurring themes of disruptions to daily life and information-seeking emerged. These findings reinforce the rationale for my quantitative approach to examining long-term associations between perceived risk of contamination and health outcomes. As I embarked on this work, I remained committed to addressing research pitfalls and biases, ensuring the community's lived experiences were faithfully represented.

By embracing methodological rigor, transparency, and ethical responsibility, epidemiologists uphold the integrity of scientific inquiry and strengthen the impact of observational research. When thoughtfully designed and interpreted, observational studies can uncover significant associations, guide interventions, and, ultimately, improve public health.

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Sara Burcham: conceptualization, methodology, formal analysis, writing–original draft, project administration, review, editing.

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COMMENTARY/POLICY

Rethinking Maternal Mental Health Solutions: Addressing Racial Disparities in Ohio and Beyond

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ABSTRACT

The maternal mental health (MMH) crisis in Ohio reflects broader national inequities, with significant racial disparities in postpartum depression, anxiety, substance use, and maternal mortality. Black, Hispanic, and other marginalized communities disproportionately experience postpartum depression and anxiety (PPD/A) due to structural racism, provider bias, and social determinants of health, while White women tend to be more affected by substance use disorder (SUD) and overdose-related maternal deaths. Despite recent policy efforts, such as House Concurrent Resolution 12 (HCR 12), Ohio's approach to MMH remains inadequate in addressing MMH and these disparities. This commentary examines the systemic drivers of MMH inequities in Ohio, highlights evidence-based strategies from other states, and calls for policy solutions that are comprehensive, data-driven, and equity-focused. Without targeted interventions, such as culturally tailored mental health care, integrated substance use and perinatal services, and expanded community-based programs, Ohio risks failing all mothers and perpetuating existing disparities. By adopting best practices from states with more effective MMH policies, as well as building on promising local efforts, Ohio has the opportunity to lead in developing equitable, actionable reforms that improve MMH outcomes across its diverse populations.

Keywords: Infant health; Maternal mental health; Structural racism; Health equity; Health disparities; Maternal mortality

INTRODUCTION

Ohio's C grade on the 2025 Maternal Mental Health State Report Card reflects a crisis that demands urgent attention. While a C grade represents improvement from previous years, it places Ohio among the majority of states failing to adequately address maternal mental health (MMH) needs, with only 5 states nationwide earning a B grade and none receiving an A. This mediocre performance also masks profound racial disparities: nationally, Black women are twice as likely to experience MMH conditions but half as likely to receive treatment compared to White women[1]; and untreated MMH disorders cost the United States $14.2 billion annually.[2] Bipartisan House Concurrent Resolution 12 (HCR 12) Recognizing the Importance of Perinatal Mental Health, introduced by Ohio State Representatives Anita Somani (D-Dublin) and Sharon Ray (R-Wadsworth), is in process of being reviewed in the statehouse in the 136th General Assembly. A house concurrent resolution is a formal expression of the intent or wish of the legislature that must be adopted by both houses but does not have the force of a law.[3] While not a binding law, passage of HCR 12 would officially recognize the impacts of MMH on families, children, and the Ohio workforce, and push the need for focused interventions in MMH. Resolution HCR 12 is an essential starting point in addressing MMH, but Ohio's approach does not yet adequately account for the specific needs of different communities. Without a proactive evidence-based implementation strategy, we are at risk of perpetuating or exacerbating existing disparities and needs gaps.

Disparities in MMH are complex, with women and birthing people who identify as Black, Hispanic, and from other marginalized communities disproportionately affected by postpartum depression and anxiety (PPD/A) driven by structural racism and provider

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bias, while White women are more impacted by substance use disorder (SUD) and overdose-related maternal mortality. Once HCR 12 is adopted, how can subsequent legislation address the diverse aspects of MMH to reduce maternal mortality and morbidity while also narrowing racial disparities in outcomes, care, and suffering? This paper discusses the systemic causes of racial disparities in MMH, points to other states' progress with equitable strategies to addressing MMH, and emphasizes the need for actionable, evidence-based strategies to address the weaknesses of states like Ohio with "grades" below B on their MMH "report cards."

Racial Disparities in Maternal Mental Health: A Divergence in Causes

Postpartum depression and anxiety (PPD/A) are significant public health concerns, disproportionately affecting Black, Hispanic, and other marginalized populations due to systemic inequities rather than inherent racial differences; according to the Ohio Pregnancy Assessment Survey (OPAS), 12.8 percent of non-Hispanic Black women in Ohio experienced postpartum depression in 2022, compared to 9.3 percent of non-Hispanic White women.[4] These disparities are driven by structural factors, including unequal access to health care, provider bias, chronic stress from racism, and social determinants of health (eg, housing and food insecurity).[5] Studies on implicit bias in health care reveal that systemic racism reduces the quality of care for Black, Hispanic, and other marginalized populations, leading to worse outcomes in MMH.[6]

Additionally, current screening tools for perinatal mental health are often based on historically White Western frameworks, which fail to capture culturally specific "idioms of distress."[7] For instance, somatic symptoms or expressions of fatigue and irritability, which may be more common among marginalized populations, are frequently overlooked, resulting in underdiagnosis or misdiagnosis.[8] This mismatch between dominant diagnostic frameworks and the lived experiences of diverse populations reinforces disparities in care and perpetuates structural inequities.[9]

Substance use disorder (SUD) represents another major contributor to maternal mortality, but the burden differs significantly by race. Data from a national analysis (2017–2020) shows a sharp rise in overdose deaths among postpartum women, with the highest incidence among White mothers.[10] This trend reflects systemic factors such as the opioid epidemic, which disproportionately affects White communities due to overprescription, economic disinvestment, and rural health care inequities. White women with SUD face barriers such as stigma, geographic limitations, and insufficient access to medication-assisted treatment (MAT).[11] However, they are more likely to be referred to treatment programs than Black women.[12]

Black women with SUD face compounded inequities due to systemic racism and provider bias. Research shows that Black women are less likely to receive MAT and are more likely to discontinue treatment prematurely due to inadequate resources and discriminatory care practices.[13] In addition, punitive policies, which are barriers to care for most mothers regardless of race,[14] disproportionately impact Black women, leading to higher rates of criminalization and child welfare interventions, which discourage seeking help.[15,16] Moreover, treatment programs often fail to address the systemic and cultural stressors, such as racism and economic inequality, that uniquely affect Black women.[17]

These divergent causes and outcomes underscore the limitations of a one-size-fits-all approach to MMH.[18-20] While White women's experiences with SUD highlight the need for expanded harm reduction programs and rural health care support, Black women's experiences require culturally competent interventions and the dismantling of punitive frameworks. Finally, stigma surrounding mental health and mistrust in the health care system impede access to care for all women and birthing people.[21] Black women, in particular, face compounded stigma rooted in intersecting oppressions of race, gender, and class. Recognizing the role of systemic oppression, historical inequities, and lived experiences of marginalization is essential to crafting effective solutions for MMH disparities.[22] Addressing these disparities requires evidence-based, tailored policies that prioritize equity and consider the distinct systemic barriers faced by different populations.

Ohio's Status in Maternal Mental Health Policy and Areas for Improvement

Ohio's MMH policies reflect incremental progress but remain insufficient to meet the diverse needs of its perinatal population, as evidenced by the state's C grade on the 2025 Maternal Mental Health Report Card, up from the 2024 C– grade.[23] As the report card highlights, this grade highlights significant gaps in areas such as screening, provider availability, and program development, despite some notable strengths. Ohio's grade places it among the majority of states with a grade of C or lower; the US average grade in 2025 was C with only 5 states earning a B and no A grades given. With its current standing and trajectory, however, Ohio is within reach of a higher grade if it builds on its recent policy advancements. One of Ohio's most significant achievements is the extension of postpartum Medicaid coverage to 12 months, ensuring more consistent health care access for new mothers. Additionally, Ohio meets key benchmarks for providers submitting claims to private insurers for both prenatal and postpartum MMH treatments, which helps ensure that more mothers receive reimbursed mental health care.

Despite Ohio's demonstrable accomplishments in the MMH space, the report also notes that the state continues to face significant weaknesses in several key areas. Both screening and screening reimbursement stand out as a major deficiency, earning the state an F grade. Ohio does not require Medicaid-managed care organizations (MCOs) to collect data on prenatal or postpartum depression screenings, nor are obstetric providers submitting claims to private insurers for even 1% of patients. This lack of systematic screening undermines early identification of MMH issues and

contributes to untreated mental illness in the perinatal population. Provider availability also remains a significant challenge, reflected in Ohio's C grade for programs and providers. While Ohio has at least one inpatient MMH treatment program and one outpatient intensive or partial hospitalization program, these resources are insufficient to address the widespread demand for MMH services.

Ohio's C grade reflects a systemic underinvestment in essential areas of MMH care. Despite progress in expanding Medicaid coverage, the report card demonstrates that the state has failed to implement policies that prioritize maternal health and well-being for all Ohioans. Addressing these gaps will require the adoption of statewide MMH screening requirements, improved data collection through Medicaid MCOs, and an increase in trained MMH providers (particularly in underserved communities), and creation of quality management programs for MMH. Without these changes, Ohio's MMH policies will continue to fall short of addressing the needs of all pregnant and postpartum women, especially its most vulnerable populations.

Recommendations for Enhancing Equity in Maternal Mental Health Care in Below-Average States

The following recommendations are designed to achieve 2 essential goals: reducing maternal mortality and morbidity for all perinatal populations, while simultaneously narrowing racial disparities. Research has consistently shown that interventions in health care focusing solely on overall improvements often fail to reduce racial disparities.[18-20] Therefore, our approach emphasizes both universal strategies that benefit all racial groups and targeted interventions that address specific inequities faced by different communities.

Integrated Substance Use and Mental Health Services

Ohio should develop integrated care models that address both MMH and perinatal substance use disorder (PSUD), drawing inspiration from Washington state's Maternity Support Services program.[24] This initiative coordinates physical and behavioral health services under Medicaid to reduce maternal mortality and improve long-term outcomes for postpartum women. This recommendation particularly addresses the needs of White women, who face disproportionately high rates of SUD-related maternal mortality as noted in our analysis, while also creating a more comprehensive care system for all racial groups. Expanding access to medication-assisted treatment (MAT) and embedding mental health professionals within perinatal care teams can ensure mothers across all racial backgrounds receive comprehensive support tailored to their specific needs. Ohio's high rates of SUD-related maternal mortality make this approach particularly urgent. Expanding access to MAT and embedding mental health professionals within perinatal care teams can help ensure mothers receive the comprehensive support they need.

Comprehensive Pregnancy Medical Home Models

Adopting a pregnancy medical home model, as implemented in North Carolina,[25] would enable Ohio to provide continuous, patient-centered care throughout the perinatal period for women of all racial backgrounds. These homes integrate obstetrics/gynecology, pediatric, and mental health services, ensuring that care addresses both universal needs and group-specific concerns. Evidence from North Carolina shows that this model reduces racial disparities in diagnosis and treatment outcomes, making it a promising framework for Ohio to replicate. This approach particularly benefits rural communities, including many White women who face geographic barriers to accessing comprehensive care, while also addressing the fragmented care often experienced by Black and Hispanic women.

Enhanced Data Collection and Analysis

Accurate and disaggregated data collection is essential for identifying gaps and guiding resource allocation that benefits all perinatal populations. Ohio must mandate the collection of MMH outcomes data by race, ethnicity, and social determinants of health. For instance, California's use of standardized data-sharing protocols in its Maternal Data Center allows for detailed analysis of both overall trends and specific disparities.[26] Adopting similar measures in Ohio, would support both universal improvements and targeted interventions to address inequities faced by specific racial groups. This data-driven approach ensures resources are allocated efficiently to serve all communities while identifying where focused efforts are needed to eliminate disparities.

Culturally Tailored Care and Provider Training

Ohio must prioritize the integration of culturally tailored mental health services into existing programs, benefiting all women while particularly addressing the needs of marginalized communities. Columbus Public Health's Hope at Home initiative, which incorporates mental health professionals into home visiting teams for pregnant and postpartum at-risk mothers, demonstrating the potential of localized, holistic care models. While this approach specifically helps address disparities faced by Black, Hispanic, and other marginalized populations, it simultaneously improves care quality for all women by increasing provider cultural competence and system responsiveness.

Ohio's approval of Medicaid reimbursement for doula services is a step forward in addressing disparities in MMH and obstetric care.[27] Doulas provide continuous, culturally sensitive support throughout pregnancy, childbirth, and the postpartum period, playing a critical role in mitigating obstetric racism and improving outcomes for Black, Hispanic, and other marginalized populations while also enhancing birth experiences and improving outcomes for women of all backgrounds.[28] However, the implementation of this policy has significant limitations. While Ohio has established a reimbursement pathway, many doulas—particularly those from underrepresented backgrounds—face barriers to participation,

including the costs of training and certification and limited infrastructure for Medicaid billing. Unlike states such as Oregon and Minnesota, which have implemented systems to recruit, train, and retain doulas from diverse communities, Ohio has yet to make similar investments.[29,30] Expanding funding to support doula training programs, particularly for Black, Hispanic, and doulas from other marginalized communities, would ensure that Medicaid-covered doula care is accessible to those most in need while building a more diverse and representative workforce that benefits all women.

Furthermore, health care providers in Ohio should also be required to undergo training in trauma-informed care, cultural humility, and implicit bias to improve interactions with diverse populations. Research shows that racial congruence between providers and patients leads to better outcomes, underscoring the importance of diversifying the maternal health workforce. Programs like California's Perinatal Equity Initiative, which funds implicit bias training and community-driven interventions, provide a model for Ohio to follow.[31] However, legislative challenges surrounding the teaching of race and equity issues in public education must be addressed to ensure sustainable progress.

Community-Based Program Expansion

Ohio has made progress with initiatives like Queen's Village in Cincinnati, a peer-support network empowering Black women through culturally tailored resources and mental health promotion. Expanding funding for community-based programs creates infrastructure that benefits all populations while ensuring culturally specific support for groups with the highest need. These community-anchored approaches can address the specific needs of White women facing SUD in rural areas, urban Black and Hispanic women experiencing PPD/A, and other distinct population needs. Mobile mental health clinics and peer support programs should be prioritized to reach underserved rural and urban populations, creating a network of support accessible to all perinatal women regardless of geographic location or racial background. Ohio could also look to California's Black Infant Health Program, which combines culturally specific case management and group-based interventions, as an example for statewide implementation.

Nonpunitive, Family-Centered Treatment Approaches

Transitioning to nonpunitive frameworks for addressing MMH and substance use issues is critical to fostering trust, reducing stigma, and improving treatment adherence for all women. While these approaches are especially impactful for Black, Hispanic, and other marginalized women who face disproportionate criminalization and family separation, they create a more effective, compassionate system for all families. Research demonstrates that family-centered approaches can improve both maternal and infant health outcomes by fostering maternal-infant bonding and reducing barriers to accessing care.[32]

Ohio could learn from Connecticut's Family-Based Recovery Program, which integrates in-home mental health and substance use services with family preservation goals, ensuring that mothers can receive treatment while keeping their families intact.[33] This program demonstrates how a shift toward collaborative, nonpunitive care models can yield positive outcomes for vulnerable families. Scaling up such frameworks within Ohio's Medicaid and home visiting programs would create a more equitable system that prioritizes long-term maternal and family well-being for all communities while closing existing gaps.

PUBLIC HEALTH IMPLICATIONS

Ohio's MMH policies must move beyond symbolic recognition to implement equity-driven, evidence-based reforms. Addressing racial disparities requires expanding culturally tailored mental health care, integrating perinatal substance use and mental health services, and strengthening community-based programs like Queen's Village. Increasing Medicaid-supported doula access and embedding MMH screening into routine care are critical next steps.

To reduce maternal health inequities, Ohio should adopt best practices from states with stronger MMH policies, such as Pregnancy Medical Homes and family-centered treatment models. Additionally, mandating robust data collection on racial and geographic disparities will enable more targeted interventions.

These recommendations form a comprehensive approach that addresses both the universal needs of all perinatal populations and the specific challenges faced by different racial groups. By implementing strategies that improve overall maternal mental health while simultaneously targeting the elimination of disparities, Ohio can build a more equitable and effective maternal health care system. A dual focus on overall improvement and disparity reduction is essential, as research consistently demonstrates that interventions lacking an explicit equity focus may inadvertently widen existing health gaps even as they improve population averages. By committing to structural change, Ohio can build a maternal mental health system that is both effective and equitable for all Ohioans.

CONFLICTS OF INTEREST

None.

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AUTHOR CONTRIBUTION

Amber Akhter: Substantial contributions to the conception and design of the commentary. Drafted the work and, along with Sarah Rubin, made the most significant contributions to the writing. Participated in critical revisions for intellectual content. Gave final approval of the version to be

published. Accountable for all aspects of the work. Sarah E. Rubin: Oversaw the project and, along with Akhter, made the most significant contributions to the writing. Participated in critical revisions for intellectual content. Gave final approval of the version to be published. Accountable for all aspects of the work. Natasha Takyi-Micah: Served as a content expert, providing key analytical contributions. Contributed to revisions for intellectual content. Gave final approval of the version to be published. Accountable for all aspects of the work. Amanda Zabala: Acted as a content expert, providing the most substantial analytical contributions. Participated in revisions for intellectual content. Gave final approval of the version to be published. Accountable for all aspects of the work.

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PUBLIC HEALTH PRACTICE

Quality Metrics in Digital Health Equity: A Systematic Evaluation of Cleveland Clinic's Ongoing Virtual Care Initiative

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ABSTRACT

Background: As digital health technologies become increasingly integrated into health care delivery, there is a pressing need to ensure that vulnerable and underserved populations are receiving the appropriate resources. The adoption of this patient-centered approach empowers patients to manage their own health through the promotion of digital equity.

Methods: A literature review and quality improvement evaluation were conducted to understand gaps in current digital equity programming at the Cleveland Clinic and identify avenues for public health collaboration within the Cuyahoga County, Ohio, community. Patients in the department of internal medicine were screened for digital needs and evaluated via confidential phone interviews. Descriptive statistics and qualitative analysis were used to evaluate the interview data.

Results: Of 2993 patients screened, 554 reported digital needs, and 395 successfully received referrals to community resources. Despite these efforts, only 27.64% of contacted patients reported receiving assistance, highlighting persistent barriers such as transportation, documentation requirements, and limited follow-up protocols.

Conclusion: Recommendations to improve digital equity include expanding transportation services, implementing digital navigator roles, and integrating community organizations into health care facilities. While the limitations of this study restrict generalizability, the findings highlight the value of adopting a comprehensive approach to achieving digital health equity and calls attention to maintaining a commitment to equitable health care access to achieve broader public health objectives.

Keywords: Digital equity; Cleveland; Telehealth; Quality improvement; Public health

INTRODUCTION

Digital equity has gained increasing recognition in recent years for its transformative value in addressing disparities in health care access and outcomes. The digital health landscape is continuously expanding, making access to such technologies crucial for advancing public health objectives. Digital health refers to the use of communication technologies to manage illnesses by reducing inefficiencies, improving the quality of care, and lowering the cost of health care.[1] This includes, but is not limited to, telehealth offerings, health analytics, and remote patient monitoring. Very few studies have systematically analyzed the contributions of digital health technology across the spectrum of disadvantaged populations due to the complexity of interactions with various social determinants of health. In this context, digital equity is focused on ensuring that all individuals have comparable accessibility to these health tools.

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The value of digital health equity goes beyond addressing immediate health disparities, though. The key stakeholders in the development of this technology include the individual end users (patients and providers) and technology proprietors that report to a larger health care system.[2] As technology becomes increasingly integrated into health care delivery, there is a pressing need to ensure that vulnerable and underserved populations are receiving the appropriate support and resources. In fact, in their global strategy for 2020-2025 the World Health Organization identified digital health as a priority.[2] The adoption of this patient-centered approach empowers individuals to manage their own health and enhances health literacy. These digital determinants of health must be addressed through a multilevel approach that targets concerns at the individual, interpersonal, community, and societal levels.[3]

The Cleveland Clinic has recognized a gap at the individual level in the accessibility of their services for many residents, identifying a key opportunity for positive change. The following objectives were proposed to identify areas for improvement within the current model of care:

1. Develop and execute surveys targeting patients facing digital inequities to collect data that reflect current patient engagement difficulties and access to digital health care resources.
2. Evaluate survey results to identify and understand gaps in digital access among impoverished populations in Cuyahoga County, Ohio.
3. Propose well informed policies that address the identified barriers to digital access and prioritize equitable health care access.

It is evident that these impoverished communities experience countless digital determinants of health that interfere with their ability to seek care and guidance in the health care space. By providing a more personalized health care experience for patients, the Cleveland Clinic is committing to fostering increased occurrences of positive health outcomes within their community. This commitment is rooted in the understanding that better patient engagement and resource distribution aligns with broader goals of health equity across various socioeconomic populations.

LITERATURE REVIEW

With the rise of the COVID-19 pandemic, limitations posed by many of the already present social determinants of health were brought to the forefront of public health efforts.[4] However, with the decline in COVID-19 rates, the concern to prioritize the digital connectivity for patients has begun to decline (R. Ranallo, MLIS, Cuyahoga County Library, oral communication, April 2024). These apprehensions are supported by a new study by the University of Cincinnati which found that disparities in digital technologies have the potential to widen the gap in health care access, especially for those living in socially vulnerable communities.[5]

The Cuyahoga County Public Library has made plans to implement technology trainers and digital navigators to help assist their patrons with technological needs (R. Ranallo, MLIS, Cuyahoga County Public Library, oral communication, April 2024). Many individuals who have reached out regarding these resources have been referred to the library to discuss telehealth and MyChart competencies. The library offers secluded computer spaces to be used to attend appointments and job opportunities, but they have seen a rise in demand for Wi-Fi connectivity over devices. There is increasing concern about the sustainability of such programs with the drop in funding post-pandemic, and the Cuyahoga County Public Library urges health care institutions to acknowledge that technology changes are overwhelming for many patients.

Additionally, MetroHealth has partnered with Dollar Bank to create a subsidy program through which they have received $600000 of funding over a 5-year period (M. Santiago-Rodriguez, MSW, MPH, MetroHealth, oral communication, April 2024). They will be collaborating with DigitalC to provide oversight and work to incorporate a digital navigator position that will help improve virtual health within the already existing MetroHealth infrastructure. There are also plans to implement a social determinant of health screening tool and provide computer classes at the Buckeye location to help with MyChart education. However, MetroHealth's focus remains primarily on administration and funding services for such efforts.

Looking outside of the Greater Cleveland area, it is valuable to recognize the efforts of the Digital Health Equity Collaborative.[6] Operational leaders, academic researchers, and patient advocates meet every 3 to 4 months to discuss ongoing and relevant topics within the digital health care space. During the most recent meeting in May, Dr. Craig, Digital Health Equity Clinical Champion at CHOP, highlighted the importance of awareness and support for digital health equity, presenting a framework involving access and sustained engagement. Dr. Briggs-Maloson, co-chair of the Health Information Technology Advisory Committee at UCLA Health, and Dr. Richardson, Director of Digital Health Equity at NYU Langone Health, both went on to stress the value of viewing digital equity as a foundational justice that requires collaboration to see a true minimization of harm.

COMMUNITY PROGRAMS

The Cleveland Clinic partners with PCsforPeople, DigitalC, ASC3, and the East Cleveland Public Library to pick up referrals for patients that are sent through the UniteUs platform. Many of these programs receive funding through the Affordable Connectivity Program (ACP) that was funded by the COVID-19 relief package under the Biden administration. The ACP Program is no longer providing funding but was submitted as a bill to Congress on January 10, 2024, as the Affordable Connectivity Program Extension Act of 2024, cosponsored by former Ohio state senators serving on the United States Senate, among other state senators.[7]

PCsforPeople offers high speed internet services for users at a reduced cost of $15 per month and access to desktops or laptop computers with prices ranging from $0 to $50. They require photo identification and documentation of current enrollment in a

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government assistance program to determine user eligibility for their services.

Similarly, DigitalC's mission is to soften the digital divide caused by the historical practices of redlining in Cleveland. They exclusively offer internet services in the Fairfax (zip codes 44103, 44104, 44106), Hough (zip codes 44106 and 44113), and Kinsman (zip code 44104) regions for a reduced cost of $18 per month with plans of expanding access throughout Cleveland in June of 2025 (L. Norris, DigitalC, oral communication, April 2024). DigitalC does not require documentation to determine user eligibility for their services. The digital equity team at Cleveland Clinic has donated $10000 to DigitalC for laptops and chargers through a 5-week program where participants can take home the device with free Wi-Fi connectivity for a year.

ASC3 (Ashbury Senior Computer Community Center) is part of the Cleveland Digital Ambassadors Group and receives funding through the Cleveland Foundation. They provide several services:

1. Digital Aviator Program (DAP) offers free computer classes that are delivered in-person and virtually. Program participants are provided with laptops and hot spots for the duration of the 6-week course.
2. Structured technology classes targeted toward different age groups and access to an open computer lab.

ASC3 also provides resources to senior individuals about other affordable internet service options:

1. New Mobile Citizen Hotspot via Sprint to provide wireless internet at $227.16 per year.
2. Internet Assist via Spectrum offers internet services at $50 to $80 per month upon completion of an online application and proof of eligibility documentation.
3. Lifeline Discount Program via Verizon offers internet services at $50 to $80 per month upon completion of an online application and proof of eligibility documentation.
4. Connected Learning Centers via AT&T helps users sign up for internet services, learn how to use computers, and improve their digital skills under the assistance of community based digital navigators.

The East Cleveland Public Library offers free computer classes to the public, in addition to their on-site computer lab. They have digital navigators to assist patrons with computer skills and loan out wireless hotspot devices for 2 weeks to library members who are above the age of 18 years with a valid ID in an East Cleveland address (zip codes 44108, 44112, 44118, 44128).

METHODS

Prior to conducting this quality improvement evaluation, the PIDAR (Partner, Identify, Demonstrate, Access, Report) framework for digital health research was identified to guide a systematic, data-driven approach in reporting the impact of digital health intervention.[8] In efforts to include diverse target stakeholders, Cleveland Clinic identified 5 main zip codes to focus on for analytical purposes: 44103, 44104, 44106, 44112 and 44113. The population of individuals in these zip codes who live at or below the federal poverty level are respectively 42.4%, 46.8%, 33%, 34.8%, and 23.2% (all of which are significantly higher than the statewide level).[9] The percentage of the population of Ohio that live at or below the federal poverty level is 13.4% compared to the national average of 11.5%.[10] The patients in these targeted areas were screened for good broadband internet, access to devices, and good literacy skills. Referrals were completed via the UniteUs platform. Patients aged 18 through 80 years were included in this initiative, with most individuals being above the age of 40 years. The quality outcome measure and primary purpose of this quality improvement evaluation project is to determine if patients successfully received assistance from a community partner and if they required additional assistance moving forward. The following screening questions were asked to understand the extent of digital inequities present:

1. Are you able to use the internet from your home to do whatever you need to do?
    a. Yes
    b. No
2. I currently have access to … (Choose all that apply)
    a. An affordable internet plan
    b. A working device that connects to the internet
    c. Knowledge and skills to access the internet using connected devices

Throughout this census, Cleveland Clinic was able to screen 2993 patients within the internal medicine department from which 554 patients reported a need. These individuals were connected with the appropriate resources to learn more about how to use the internet and gain access to the digital tools available to them. These resources were obtained in collaboration with the community-based organizations outlined above. A 40% gap closure for providing patients with resources through this intervention was reported by Cleveland Clinic.

The next aim was to report the impact of this programming to determine effectiveness and areas for improvement. To conduct this quality improvement evaluation, a questionnaire was distributed via phone to 395 patients who received a screening and referral after indicating a need. This questionnaire was delivered via phone to collect information about patient experiences. The following questions were included in the survey:

1. You were previously screened for:
    a. Device
    b. Connectivity
    c. Understanding of how to use device/internet
2. Did you successfully get connected to a resource?
    a. Yes
    b. No
3. Are you on MyChart?
    a. Yes
    b. No

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4. Would you like to learn more about how to use MyChart?
    a. Yes
    b. No

For analysis purposes, the data collected from the questionnaire above were used to create a percent success rate based on the number of patients who successfully received an intervention. The patient's name, identification number, and date of birth were entered into an Excel spreadsheet. The data were further broken down by zip code, intervention required (device, internet, training classes), race, gender, and age.

This information helped in understanding if there has been an increase in patients' digital behavior. Cleveland Clinic was evaluating if the resources that patients received contributed to their digital health. Information from the social determinants of health screenings were also included in the data collection process to identify potential trends present within the patient dataset. All phone call attempts and communication with patients through community partners are recorded within the UniteUs platform. The referrals for patients who still reported a need were checked in UniteUs to gain a full understanding of the referral process and investigate why they were not connected with a resource.

This project was conducted under the scope of a quality improvement project with a focus on evaluating and enhancing current health care processes. Institutional policies were followed to guarantee that all ethical considerations were maintained. Patient data was securely stored with restricted access, and referral records were managed in the HIPAA-compliant UniteUs platform. All findings have been reported in an aggregate format to ensure that data cannot be traced back to any individual patients, prioritizing patient anonymity and data integrity.

RESULTS

Of the 395 patients included in the patient screening, 389 patients identified as Black (98.48%), 5 patients identified as White (1.27%), and 1 patient identified as Asian (0.25%). Of the 395 patients included in the patient screening, 260 patients were 18 to 64 years of age (65.82%) and 135 patients were over the age of 65 years (34.18%). The majority of patients (35.70%) were located in the 44112 zip code region.

Of the 395 patients that were included in the primary digital health screening, 123 were successfully contacted with over half of the primary patient set being unable to contact. Of these 123 patients, 34 reported that they had received assistance by one of Cleveland Clinic's community programs. This demonstrates a 27.64% success rate since success was defined as receiving assistance, regardless of whether that patient still required additional assistance. Of the 123 patients contacted, 104 required an additional referral for their needs to be appropriately met. From those who required an additional referral, 12 patients did not receive assistance primarily as they were unable to come into the office or were unable to provide the appropriate documentation to determine eligibility, and 15 patients had received assistance from a community program but the resource was no longer working for them.

RECOMMENDATIONS

Before looking for ways to improve the number of patients attending these appointments and meetings, it is important to recognize contributing factors to such behaviors. A study conducted by the University of Nebraska Medical Center showed that as many as 45% of patients fail to keep their scheduled appointments.[11] The primary reasons for no-shows were that (1) some patients are anxious, (2) some patients feel disrespected by the health care system, and (3) some patients simply do not understand the scheduling system.[11] Keeping this information in mind, it is evident that addressing these underlying issues is crucial for an improved intervention strategy.

Challenge 1

Patients are being successfully contacted by local organizations upon referral but remain unable to come to in-person meetings to get set up with the appropriate resources. Lack of transportation delayed 5.8 million people in the United States (1.8%) from receiving necessary medical care in 2017.[12] In fact, 28 of the patients from the initial set of 395 had indicated transportation needs in their social determinants of health screenings. Providing transportation services for free or at a reduced cost has the potential to bridge this gap in barriers to health care access.[13]

Table 1. Patient Population Demographics

	White	Black	Asian	Total
Gender				
Male	1	139	0	140
Female	4	250	1	255
Age				
18-64 years	5	254	1	260
65+ years	0	135	0	135
Region (by zip code)				
44103	0	126	0	126
44104	0	36	0	36
44106	4	86	1	91
44112	1	140	0	141
44113	0	1	0	1
Total	5	389	1	395

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Challenge 1, Proposed Solution 1: Stephanie Tubbs Jones and Langston Hughes Shuttle Service Expansion

The current shuttle service is used to help patients attend clinical service appointments. By utilizing and building upon the existing infrastructure of the shuttle service, Cleveland Clinic can foster a sense of community and has the potential to be a cost-effective solution. Expanding the routes and increasing the frequency of shuttle services will allow Cleveland Clinic to serve a broader geographic area. This can be done by adding stops at community centers and other locations where patients may receive supplementary services that contribute to their overall health. However, it is important to consider the required coordination between health care providers and the transportation services to ensure accessibility for patients.

Challenge 1, Proposed Solution 2: Uber Health

Uber Health is a "HIPAA-enabled platform for non-emergency medical transportation services upon health care provider request to monitor patient rides without patients needing the Uber app or a smartphone."[14] This option reduced some of the technological barriers involved with transportation services and exists as a flexible, on demand service. Developing clear guidelines for eligible rides and the approval process will be essential in understanding the logistical components of creating such a system for patients.

Challenge 1, Proposed Solution 3: Integrate Community Partners On-Site

Bringing the community partners into current Cleveland Clinic buildings can provide patients with easier access to available services. For example, the Langston Hughes site already houses community support services and can be enhanced to serve as a holistic care center to improve overall patient outcomes. By co-locating community organizations within medical centers, patients will no longer have to travel to separate locations, further reducing the burden and barriers to access.

Challenge 2

Patients are unable to provide the appropriate tax information and documentation to determine eligibility for subsidized services. During interaction with community programs, many patients were unable to progress past initial screening due to these barriers, thereby limiting their access to the available resources. This information was noted in each patient's individual referral log within the UniteUs platform.

Challenge 2, Proposed Solution 1: Implementation of Digital Navigators

Working alongside the current Community Health Worker Program, the addition of digital navigators creates a formal position for "trusted guides who assist community members with ongoing, individualized support for accessing affordable and appropriate connectivity, devices, and digital skills."[15] It should be noted, though, that this requires the development of a comprehensive training program and providing these navigators with the necessary equipment to appropriately deliver assistance. The Hennepin County Medical Center in Minneapolis, Minnesota, recently launched a digital navigator program that helped more than 800 people access their health records and other digital tools within just one year.[16]

Challenge 2, Proposed Solution 2: Create a Space for Community Health Workers in Clinical Waiting Rooms

By placing community health workers directly in the clinical setting, patients have immediate access to individuals who can help them to navigate the health care space. Many patients, especially those from vulnerable communities, face barriers in health paperwork, anxiety when working with providers, or language barriers, among others. Community health workers can provide in-person support and build rapport with patients who may be overwhelmed. Their presence can create a more welcoming environment and contribute to a more efficient workflow, as well.

Table 2. Summary of Key Challenges and Recommended Solutions

	Challenge 1	Challenge 2	Challenge 3
Solution 1	Pro: Utilizes existing infrastructure for cost-saving purposes Con: Potential for limited coverage and scheduling flexibility	Pro: Provides personalized support for patients Con: Requires investment in training and equipment	Pro: Improves efficiency and rate of successful patients contacted Con: Requires changes to existing workflow and may result in resistance from staff
Solution 2	Pro: On-demand service that reduces technological barriers Con: Potential higher cost per ride that may not be suitable for all patients	Pro: Immediate access to support services can improve patient outcomes Con: May require additional staffing and resource allocation	Pro: Leverages existing relationships to increase engagement Con: Potential to introduce referral biases and requires community training
Solution 3	Pro: Reduced burden for transportation and promotes holistic care Con: May require significant resource allocation	N/A	Pro: Reaches a broader audience through existing infrastructure Con: Requires coordination with external organizations

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Challenge 3

There is no follow-up protocol when we are unable to contact patients via phone for referrals, creating a lack of communication. The current follow-up procedure states that after 3 phone call attempts, the patient will be marked as "unable to contact." Under these rules, only 31.14% of patients were able to be contacted for a follow-up interview, indicating room for improvement.

Challenge 3, Proposed Solution 1: Streamline Referral Process

By creating clear referral criteria for physicians and other health care professionals, the likelihood of successful contact through targeted referrals can increase. Patients should continuously be evaluated for social determinants of health and this holistic approach can allow for early identification in patients who may need additional support. To ensure effective implementation, it is important that the screening process is integrated into training for health care professionals so that they can recognize how to make referrals when necessary. Some potential challenges include ensuring consistency across different health care providers and resistance to change due to already existing time constraints within the clinical setting.

Challenge #3, Proposed Solution #2: Implement Community Referrals

Implementing a social credit system can allow long-standing community members to refer their friends and family for support services. Not only does this leverage existing community relationships, but it also increases community engagement in health initiatives. Providing training to community members about the various available services can help create a user-friendly referral network that circumvents patients that Cleveland Clinic is unable to contact.

Challenge 3, Proposed Solution 3: Expand Community Networks

Expand the utilization of community networks, especially within the free library system, that already have an established level of trust with community members to educate patients about such services. A study in North Carolina found that "with minimal investment, rural public libraries can support healthy lifestyle activities and improve community awareness."[17] By tapping into existing infrastructure, Cleveland Clinic can reach a broader audience and include those who may not regularly interact with the health care system. Developing health education materials can assist in the distribution of knowledge through these networks.

DISCUSSION

To improve Cleveland Clinic's ongoing Digital Health Equity initiative, integrating community organizations within the Langston Hughes Center is recommended to address Challenge 1. This is a beneficial long-term solution that encourages a more integrated care model while still maintaining the existing responsibilities of Cleveland Clinic as a health care institution. To combat Challenge 2, the implementation of a Digital Navigator Program is recommended as it addresses both documentation and digital literacy issues. Furthermore, a streamlined referral process with expanded community networks is suggested for Challenge 3 due to its ability to improve existing internal processes while leveraging external resources.

Some of the strengths for this study were the comprehensive approach regarding the breadth of data collected. It addresses multiple challenges in patient engagement and access to care, beyond just digital access. The collected data demonstrates clear gaps in implementation, indicating room for positive improvements as seen through the several solution approaches outlined. The findings are limited due to the small sample size and barriers in contacting all the patients for a follow-up questionnaire. Additionally, the geographic specificity of the patient population included in this study limits generalizability to other regions in the state of Ohio. However, the findings remain significant, and I anticipate that the final recommendations will be comprehensive and practical for implementation.

CONCLUSION

Upon analysis, Cleveland Clinic plans to implement a community health worker that is solely dedicated to ensuring that patients have internet access and are knowledgeable in that realm. Additionally, they are in the process of applying for the National Telecommunications and Information Administration's Digital Equity Competitive Grant Program through which they will fund the digital navigator role. In conjunction, Cleveland Clinic wants to make efforts to develop an ongoing and sustainable model for a digital health program that can be implemented across Cleveland Clinic sites.

The anticipated steps that Cleveland Clinic is taking are promising for addressing digital barriers. Their plans to target patient engagement and health literacy will address significant gaps in the current model of care. Some additional considerations are to consider improving coordination between clinical teams and community services, as well as the exploration of alternative engagement strategies for nondigital patients. It should be recognized, though, that these steps demonstrate a commitment to improving patient access to health care while addressing the many social determinants of health that exist as barriers for many in the local community.

PUBLIC HEALTH IMPLICATIONS

The inability to access digital resources continues to exacerbate existing health disparities. Digital health technologies impact health care delivery, disease management, and patient engagement. The findings of this study demonstrate that addressing equitable access at the systematic level has the potential to drastically improve health outcomes. Focusing on transportation and health literacy is pertinent as they continue to impede upon ongoing intervention efforts in the community.

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AUTHOR CONTRIBUTION

All authors contributed to the concept and design of the study. Aashna Rana conducted quantitative data collection, qualitative interviews, and data analysis. All authors assisted with revising the work critically for important intellectual conduct and agreed to the final version to be published.

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ERRATUM
07/16/2025: Corrected percentages in second and third sentences of Results section. Inserted "successfully" into first sentence of second paragraph of Results section. Inserted reference #8 and updated references following the insertion. Corrected and updated citations within the text to reflect the reference insertion.

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