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Kevin Murray, OSU BS Design 2019, cover illustrator Paul Nini, OSU Professor of Design, faculty advisor



### **EDITORIAL**

### The Ohio Journal of Public Health: A Platform to Showcase Public Health Education, Practice, and Research in Ohio

Amy Ferketich, PhD

The Ohio State University College of Public Health, Columbus, OH

Welcome to the inaugural issue of the *Ohio Journal of Public Health (OJPH)*. This new journal will feature articles on public health education, practice, and research that are relevant to public health professionals in Ohio. The idea for the Journal came from Joe Ebel and Lois Hall during their terms as President and Executive Director, respectively, of the Ohio Public Health Association (OPHA). Early in 2018 the Governing Council of OPHA approved the guidelines for the Journal and here we are, several months later, rolling out the first issue which features an Op-Ed, five peer-reviewed research papers, and a research brief all written by researchers in Ohio.

In this issue, you will read an Op-Ed about HIV pre-exposure prophylaxis (PrEP) and how its use may have an unintended consequence. The research articles and brief cover a variety of important public health topics. Two papers are focused on physical activity. In one, Smock and colleagues report the extent to which Northeast Ohio health care providers prescribe exercise to the patients in their practice. In the second, Nolan and Hallam present a scale that measures exercise self-efficacy, and the psychometric properties of the scale were established in a sample of Ohio adults. Another paper, written by Wallace and co-authors, is about the relationship between age, body mass index, and knee osteoarthritis among middle-age and older adults, including adults from Ohio. In another paper, Embree and colleagues present the results from an ecological analysis that explored the relationship between county-level factors and suicide rates over a 10-year period (2007-2016) in Ohio. The last research article, authored by DiPietro and collaborators, examines the extent to which Ohio health care providers are discussing reproductive life plans with their patients. Finally, in the research brief, Hardin and Roberts report the change in smoking prevalence among college-aged individuals who participated in a summer work program in Appalachia. All of the articles address important public health issues in Ohio and their publication in the Journal will hopefully stimulate conversations between researchers and practitioners.

I am thrilled to have the opportunity to serve as the founding Editor-in-Chief of the Journal. In this role, I will assure that all submissions undergo a rigorous and fair peer-review process and that all publications clearly describe the relevance to public health in Ohio. This latter point is critical, given that the mission of OPHA includes "to be the inclusive Voice of Public Health in Ohio and to advance the practice of public health in Ohio." The Journal will provide another avenue for OPHA to serve as the "Voice of Public Health" in our state. I am hopeful that articles appearing in the Journal will enable Ohio public health professionals to disseminate their best practices more quickly to the community. I am also optimistic that the Journal will encourage collaboration across local and state public health organizations and universities in Ohio. Ohio Journal of Public Health, November 2018, Vol. 1, No. 1 ISSN: 2578-6180



### OP-ED

#### PrEP and condom use: A tale of unintended consequences?

Lauren Maziarz, PhD

Assistant Professor, Bowling Green State University, OH

Corresponding Author: Lauren Maziarz • 120 Health and Human Services Bldg • Bowling Green, OH • (419) 372-7725 • Imaziar@bgsu.edu

Last year marked the 4th consecutive record year for new cases of sexually transmitted diseases (STDs) in the United States, with 2.3 million diagnosed cases of chlamydia, gonorrhea, and syphilis.<sup>1</sup> Ohio continues to have one of the highest prevalence of STDs, ranking 14th in reported chlamydia cases and 11th in reported gonorrhea cases in 2016.<sup>2</sup> Gonorrhea is of particular concern to public health professionals, as the prevalence of antibiotic resistant strains has increased significantly over the last 20 years.<sup>3</sup> The mainstays of STD prevention continue to include barrier protection (e.g., latex condoms and dental dams), and yet condom use remains low with only 23.8% of women and 33.7% of men wearing condoms at their last sexual encounter in the past 12 months.<sup>4</sup> To be fair, persuading people to use condoms has never been easy but the stakes are getting even higher as our treatment options dwindle.

Public health professionals protect the health of the public, which can at times include assessing the inadvertent outcomes of medical progress. One example of an important biomedical breakthrough in the area of human immunodeficiency virus (HIV) prevention is PrEP, short for pre-exposure prophylaxis, which is a daily oral medication used to prevent the acquisition of HIV in high-risk individuals. When taken consistently, PrEP reduces the risk of HIV acquisition by as much as 90%, and is even more effective when used with other prevention methods, such as condoms.<sup>5</sup>

Among men who have sex with men (MSM), the highest-risk population for HIV, reducing the fear of HIV through PrEP has the potential to increase risky sexual behavior, such as condomless sex. In a 2018 systematic review of PrEP use and sexual behavior in MSM, researchers found an increase in self-reported condomless sex among PrEP users in some, but not all, of the studies included for review.<sup>6</sup> These findings speak to the theory of risk compensation, whereby individuals adjust their behaviors in response to perceived level of risk. As other researchers have also noted, as we continue to take perceived risk of HIV out of the equation we may be losing ground on prevention of other STDs. <sup>7,8</sup>

Of course we cannot determine why new cases of STDs continue to increase without adequate funding and attention from Congress. Funding for STD prevention programs supported by the Centers for Disease Control and Prevention has decreased 50% over the last 15 years.<sup>9</sup> We are left dealing with the consequences of an area of public health left underfunded and ignored. The research is not yet clear what effect, if any, PrEP has on condom use and risk compensation, especially for high-risk populations other than MSM, but there is a growing consensus among public health professionals that increased rates of STDs are an unintended consequence of an important medical innovation. <sup>6,7,8</sup> Public health professionals, as well as PrEP users, must now decide if the benefit of PrEP, a lifesaving drug, outweighs the costs of acquiring other less harmful STDs, many of which are routinely screened for and easily treated with well-tolerated antibiotics. The cost-benefit ratio is delicate but having access to adequate STD services is an essential step in preventing further morbidity. Ohio's public health community should demand support for STD prevention, screening, and treatment from the state legislature, especially as STDs continue to reach record highs.

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## **RESEARCH ARTICLE**

# Ohio providers' practices and barriers to use of reproductive life plans and long-acting reversible contraception with patients and clients

Natalie DiPietro Mager, PharmD, MPH<sup>1,2</sup>; Brad Lucas, MD<sup>1,3</sup>; Michelle Clark, RN<sup>1,4</sup>; Molly Kelly, RN<sup>1,4</sup>; Patricia Gabbe, MD<sup>1,5</sup>

<sup>1</sup>Ohio Collaborative to Prevent Infant Mortality, Columbus, OH

<sup>2</sup>Ohio Northern University, Ada, OH

<sup>3</sup>Buckeye Health Plan, Akron, OH

<sup>4</sup>Ohio Department of Health, Columbus, OH

<sup>5</sup>The Ohio State University, Columbus, OH

Corresponding Author: Natalie DiPietro Mager • Ohio Northern University • 525 S. Main St, Ada, OH • 419-772-3971 • n-dipietro@onu.edu

#### ABSTRACT

**Background:** Creating reproductive life plans, assessing pregnancy intent, and discussing long-acting reversible contraception (LARC) can reduce unintended pregnancies and promote women's health before and between pregnancies. The primary objective of this study was to collect information from Ohio health workers on knowledge, use, barriers, and perceptions of reproductive life plans. Secondary objectives were to determine whether health workers systematically ask female clients/patients about pregnancy intent, include information on LARC when discussing contraceptive options, or encounter barriers to these practices.

Methods: A 13-item survey was sent electronically utilizing a snowball sampling design to Ohio Collaborative to Prevent Infant Mortality members and to nurses and providers working with women of reproductive age in Ohio who had current certifications listed in public access state licensure files. Chi-square tests were performed to identify associations between response to survey questions (yes/no) and respondent position (physician/advanced practice nurse/nurse).

**Results:** Four hundred fifty-two responses were analyzed; 81% were physicians, advanced practice nurses, or nurses. Among respondents, 47% indicated routinely asking all reproductive age females if they plan to become pregnant in the next year; 47% indicated knowledge of reproductive life plans; 28% reported using reproductive life plans with clients/patients; and 72% reported discussing LARC with clients/patients. Significant differences in these practices were seen based on respondent position. The most commonly reported barriers were provider attitudes/knowledge, client/patient attitudes, workflow disruption, and time.

**Conclusions:** Inconsistencies were seen in the delivery of these practices. There is a need for education about these practices and to develop solutions to barriers.

Key words: pregnancy intent; reproductive life plan; long-acting reversible contraception; unintended pregnancy

(doi number goes here)

#### INTRODUCTION

Unintended pregnancy refers to a pregnancy that was desired later or never. Unintended pregnancies can detrimentally affect maternal and child health outcomes and result in economic and social challenges for women and families.<sup>1,2</sup> Approximately 45% of all pregnancies in the United States and 55% in Ohio are unintended.<sup>3,4</sup>

There are several strategies health workers can employ to reduce unintended pregnancy. These include systematically asking patients or clients about pregnancy intent, working with patients or clients to develop reproductive life plans, and discussing highly effective forms of contraception (such as long-acting reversible contraception or LARC) with women of reproductive age. These strategies also serve to improve women's health and birth outcomes by facilitating safe birth spacing and by providing opportunities to address medical, behavioral, or social issues as needed before and between pregnancies.<sup>5-7</sup> Systematic inquiry about pregnancy intent involves asking a woman of reproductive age at every encounter whether she would like to become pregnant or could possibly become pregnant in the next year and provides health workers important information and guides next steps to provide either preconception or contraception counseling and to refer women as appropriate.<sup>5</sup> Programs such as The One Key Question<sup>®</sup> Initiative have been developed to facilitate implementation of this practice in primary care.<sup>8</sup> Reproductive life plans are comprehensive tools that women can utilize to set life goals around childbearing during the family planning process and may identify potential risks that need to be addressed before pregnancy to improve outcomes.<sup>9</sup> For women who want contraception, information on LARC should be shared as they are among the most effective methods available and they can be easily removed and result in a return to fertility. LARC use is widely recognized as an integral path to birth spacing and the pregnancy preparation that can coincide.<sup>6,7</sup>

In Ohio, the Ohio Collaborative to Prevent Infant Mortality (OCPIM) was formed with stakeholders from across the state to address the issue of high infant mortality.<sup>10</sup> Seven action groups were formed within OCPIM. Due to the high rate of unintended pregnancy in Ohio,<sup>4</sup> Action Group 2: Promoting Optimal Women's Health Before, During, and After Pregnancy decided to first focus on reproductive life plans, pregnancy intent, and LARC. As it was not known how often these practices were being performed in Ohio, an exploratory survey was conducted to collect baseline data with the intent to inform action steps if needed to increase use of these practices.

#### **METHODS**

#### Setting:

The study was conducted in Ohio with providers working with reproductive-age women.

#### Design:

The study utilized an electronic survey disseminated via email to capture the information of interest. The primary objective of the survey was to collect information on knowledge, use, barriers, and perceptions related to reproductive life plans. Secondary objectives were to assess whether health workers were systematically asking female clients/patients about pregnancy intent, including information on LARC when discussing contraceptive options, or encountering barriers to these practices.

#### Participants:

Members of the Ohio Collaborative to Prevent Infant Mortality as well as nurses and providers (family medicine, family practice, internal medicine, general practice, gynecology, and obstetrics/ gynecology [ob/gyn]) with current certifications listed in public access state licensure files received the survey. Survey recipients were asked to complete the survey and to forward it on to other health workers they know in the state who work with reproductive-age women.

#### Procedures:

A 13-item survey instrument was developed. The survey questions were entered into Qualtrics Labs Inc (Provo, UT) software. This tool was pilot-tested by volunteers of the Ohio Collaborative to Prevent Infant Mortality before distribution to assess face validity and to check for any technical difficulties. A cover letter stating the purpose of the survey and encouraging recipients to complete the survey, even if they were not familiar with the concepts described in the cover letter, was drafted to accompany the survey.

The cover letter containing the link to the survey was sent via email to members of the Ohio Collaborative to Prevent Infant Mortality and to nurses and providers with current certifications listed in public access state licensure files. A snowball sampling technique was utilized whereby email recipients were asked to forward the survey email to colleagues in Ohio who work with reproductive-age women. Surveys were completed anonymously. No incentive was offered for responding to the survey. The survey results were collected in April-June 2016. The survey was deemed exempt by the Ohio Northern University Institutional Review Board.

#### Measures/outcomes:

Four survey questions assessed demographic information (geographic location – county and state; position; type of agency/ worksite). Multiple-choice questions assessed whether respondents routinely asked women of reproductive age whether they plan to become pregnant in the next year; respondents' knowledge, use, and perceived benefits of reproductive life plans; and whether respondents included LARC when discussing contraceptive options with their female patients or clients. Barriers preventing current implementation of these three practices were assessed through multiple choice and free text responses. The final survey item was optional and consisted of a free text box where respondents could leave any feedback or comments.

#### Statistical analysis:

Quantitative data were analyzed using Microsoft Office Excel 2013 (Redmond, WA), IBM SPSS version 22 (Armonk, NY), and ESRI ArcMap (Redlands, CA). Chi-square tests were performed to identify associations between response to survey questions (yes/ no) and respondent position (physician/advanced practice nurse/ nurse) with statistical significance defined a priori as < 0.05. A thematic qualitative analysis was performed on the open-ended responses. Inductive coding was performed manually by one researcher on the team creating a flat frame of categories that grouped similar thoughts, ideas, or experiences submitted by survey respondents. The researcher conducted three rounds of review of the open-ended responses; the first two rounds of review were used to generate the final list of codes and the third round was performed to assign responses to the final code.

#### RESULTS

Five hundred thirty-nine individuals completed at least 70% of the survey. Of those, 85 were excluded for reasons such as not working in Ohio; retired; unemployed; work does not include direct contact with clients/patients; or work focuses on the elderly. Data from 452 individuals were analyzed, 95% of which completed the survey in its entirety. Table 1 lists their demographic characteristics. Physicians, advanced practice nurses, and nurses comprised 81% of survey respondents. The most common worksites for physicians who responded to the survey were private practice (39%), health center (23%), and federally-qualified health center (FQHC) (9%); for advanced practice nurses, health center (26%), FQHC (14%), and private practice (13%); and for nurses, local health department (33%), FQHC (16%), and health center (13%).

Table 1: Demographic characteristic	
of survey respondents (n=452)	
Characteristic	n (%)*
Position	
Advanced practice nurse	126 (28%)
Community health worker	9 (2%)
Medical assistant	5 (1%)
Midwife	5 (1%)
Nurse	90 (20%)
Other, please specify (free text responses	40 (10%)
included case manager, counselor,	
health educator, home visitor)	
Physician	150 (33%)
Social worker	18 (4%)
Blank	2 (0.4%)
Agency/Worksite	
Community hub	5 (1%)
Family health center	29 (6%)
Family private practice	35 (8%)
Federal	6 (1%)
Federally qualified health center	65 (14%)
Health plan	13 (3%)
Home visiting	7 (2%)
Internal medicine	19 (4%)
Local health department	52 (12%)
Mental health	16 (4%)
Ob/gyn health center	35 (8%)
Ob/gyn private office	44 (10%)
Other, please specify (free text response included	94 (21%)
academic medical center, college health	
center, correctional facility, hospital, free clinic,	
family planning clinic, mobile clinic, retail clinic,	
urgent care)	
Pediatric health center	24 (5%)
Pediatric private office	3 (0.6%)
School	2 (0.4%)
State health department	2 (0.4%)

\* percentages may not total 100 due to rounding



Figure 1 illustrates the distribution of respondents by county. At least one survey response was received from each of Ohio's 88 counties. The two counties with the highest number of survey respondents were Franklin and Cuyahoga, where Columbus and Cleveland are located respectively. Table 2 shows respondent's practices and knowledge regarding systematic inquiry about pregnancy intent, reproductive life plans, and LARC.

Table 2: Respondents' self-reported practicesand knowledge (n=452)						
Characteristic	Yes	No	Blank			
	n (%)	n (%)	n (%)			
Do you routinely ask all reproductive-age females in your practice if they plan to become pregnant in the next year?	214 (47%)	235 (52%)	3 (0.7%)			
Do you know what a reproductive life plan is?	214	231	7			
	(47%)	(51%)	(2%)			
Do you use reproductive life plans with your patients/clients?	125	302	25			
	(28%)	(67%)	(5%)			
Do you include discussion about long-acting re- versible contraception (LARC) when you advise on contraception options with your patients/ clients?	325 (72%)	122 (27%)	5 (1%)			

\* percentages may not total 100 due to rounding

#### Systematic Inquiry about Pregnancy Intent

Forty-seven percent of respondents answered yes to the question "Do you routinely ask all reproductive-age females in your practice if they plan to become pregnant in the next year?" More nurses (55%) and physicians (52%) reported this practice as compared to advanced practice nurses (33%, p<0.001). The majority of respondents at three types of worksites indicated routinely asking this question of their clients/patients: local health departments (85%), ob/gyn private practice (82%), and ob/gyn health center (74%); at all other worksites, the majority of respondents did not routinely use this practice. Barriers to this practice included disruption in organizational workflow (n=41), client/patient attitudes (n=38), and provider attitudes/knowledge (n=13).

#### **Reproductive Life Plans**

Forty-seven percent of survey respondents indicated knowledge of reproductive life plans. The majority of nurses (74%) responding to the survey answered yes to the question, while the majority of advanced practice nurses (58%) and physicians (71%) answered no to the question (p<0.001). The only worksite for which the majority of respondents reported knowledge of reproductive life plans was the local health departments (90%); at all other worksites, the majority of respondents did not know what a reproductive life plan is.

When asked "Do you use reproductive life plans with your clients/patients?", 28% of survey respondents answered yes. Among nurses, 50% reported use of reproductive life plans with their clients/patients; among advanced practice nurses and physicians the percentage dropped to 17% and 15%, respectively (p<0.001). The only worksite for which the majority of respondents reported using reproductive life plans was local health departments (81%).

Frequency of reproductive life plan use with patients/clients was also assessed (Table 3). Respondents were asked to indicate on a 1-10 scale whether they thought reproductive life plans were helpful for their patients/clients (1=most helpful, 10=not at all helpful). The mean response was 5.1 (standard deviation 2.5). Barriers to this practice included provider attitudes/ knowledge (n=62), client/patient attitudes (n=51), disruption in organization-al workflow (n=29), and time (n=9).

Table 3: Frequency of use of reproductive life planswith patients/clients (n=125)					
Frequency	n (%)				
Annually	43 (34%)				
At every visit	22 (18%)				
With any changes	20 (16%)				
With new clients/patients	14 (11%)				
Other, please specify (free text responses included every 6 months, occasionally/ intermittently, patient request, postpartum, provider request)	25 (20%)				

#### Long-Acting Reversible Contraception (LARC)

Seventy-two percent of survey respondents said that they include discussion about LARC when advising on contraception options with their clients or patients. Eighty-nine percent of physicians and 73% of nurses, compared to 58% of advanced practice nurses, reported this practice (p<0.001). Fifty percent or more of respondents from nearly all worksites answered yes to discussing LARC; the only exceptions were pediatric health center (29%) and mental health (18%). Barriers to discussing LARC included "lack of knowledge" (n=13), "institutional barriers" (e.g., Catholic institution, only provide barrier methods, etc) (n=6), "unable to provide" (n=5), "patients already pregnant" (n=2), "religious beliefs" (n=2), "not a first choice" (n=1), "not safe" (n=1), and "pediatrics practice" (n=1).

#### **Open-Ended Comments**

Seventy-one survey respondents provided comments at the end of the survey. Common themes emerged. Nine respondents indicated that while they do not use a formal process to discuss reproductive life plans, they believe they probably cover the necessary elements with their patients/clients; one respondent indicated "I do contraception counseling but have not formally done reproductive life planning with patients. Will consider this formal addition to care" [advanced practice nurse]. Two expressed concern about introducing additional paperwork or another process into their sessions with clients/patients, and one respondent indicated that while supportive of the practice, clinic workflow did not permit use of reproductive life plans. Several (n=6) indicated they would like additional information about the practices discussed in the survey, with one respondent requesting a staff education or lunch-and-learn meeting. Other representative comments included: "It all sounds good but I don't exactly know what reproductive life plans are" [family medicine physician]; "I am not familiar with reproductive life plans but I am not opposed to using them" [advanced practice nurse]; 'I'm sorry to say I don't know exactly what a reproductive life plan consists of" [advanced practice nurse]; "I think if I knew more I would talk about this with patients" [advanced practice nurse].

#### DISCUSSION

To our knowledge, this is the first study performed on a statewide level that collected information from multiple types of health workers from various worksites on all of these practices in a single survey. This survey reached a large number of various health workers in different worksites across the state who interact with women of reproductive age. The results of the survey revealed that there were some gaps and inconsistencies in regards to the conversations around contraceptive choices and reproductive life plans in Ohio. The majority of survey respondents were not knowledgeable about reproductive life plans and thus were not using reproductive life plans, and were not routinely asking women of reproductive age about their intent to become pregnant in the next year. This represents missed opportunities to help women identify the most effective contraceptive option and to improve outcomes by proactively identifying and addressing necessary issues prior to pregnancy.

Education about reproductive life plans and best practices associated with their use, including how frequently health workers should have this discussion with women, should be made widely available. As this practice seems to be most prevalent in local health departments, health departments may consider reaching out to medical providers in their community to share information about reproductive life plans to promote its use in private practices. Health workers should also be made aware of the importance of routinely asking women about their intent to become pregnant. While this practice seems to be occurring more regularly at local health departments and ob/gyn clinics, there is a great need to educate those at other worksites about this technique. Based on the feedback received by survey respondents, many are interested in receiving education to facilitate appropriate care and referrals based on patient/client response to reproductive life plans; algorithms for preconception care may be useful.<sup>11,12</sup>

Barriers reported by survey respondents should be addressed so that they can adopt these practices at their worksites. While it was encouraging that the majority of survey respondents did include LARC when discussing contraceptive options with patients/ clients, some of the barriers reported in the free text box warrant further education for health workers. Some respondents indicated that the reason they do not discuss LARC is because they do not have enough information and/or do not feel knowledgeable about it. Additionally, responses that represent potential misconceptions, such as I only see pregnant patients, pediatric practice, and not safe, should be addressed through educational programming. Respondents from health centers that serve a small percentage of women of reproductive age did not usually discuss LARC; as a smaller number of survey responses were received from these worksites, a survey focused on those worksites may be conducted to more fully assess practice at these locations.

Limitations to these results include possible respondent bias. However, the cover letter explicitly asked recipients to take the survey, even if they were unfamiliar with the topic. Additionally, due to the non-random sampling technique, these results may not be representative of practices among all disciplines, worksites, or counties in Ohio. As this was an exploratory study to gather baseline information regarding the practices and barriers, there were no previous data from which to derive power calculations. Therefore, it is possible that there were differences among respondents that were not detected due to inadequate sample size.

Few studies asking similar questions to this survey regarding reproductive life plans or LARC have been conducted in the United States at a statewide level; results were comparable to those seen in Ohio. In Delaware, a survey was sent in January 2011 to members of the Delaware Academy of Family Physicians, the Delaware Chapter of the American Academy of Pediatrics, and the Delaware Chapter of the American College of Obstetrics and Gynecology to assess knowledge of various aspects of preconception health care.<sup>13</sup> Among the 94 respondents, 34% indicated that they "often" or "always" discussed reproductive life plans with patients while 28% indicated that they "rarely" or "never" discussed reproductive life plans with patients. Barriers to this practice were not assessed. In California, a study conducted in September 2011 surveyed a sample of medical directors of the state's Medicaid family planning program.<sup>14</sup> Of the 587 respondents, 74% reported discussing intrauterine devices and 49% reported discussing implants with "most" or "many" patients needing contraceptive services. The investigators found that there were misconceptions among some respondents regarding populations eligible for LARC and appropriate timing of LARC insertion.

Future research may involve targeted surveys focused on certain worksites or provider types in Ohio. Additionally, based on these baseline survey results, strategies to increase use of these practices across the state are being developed. For example, OCPIM Action Group 2 has posted various reproductive life plans used by state and local health departments online,<sup>15</sup> and an online LARC toolkit is currently in development. A follow-up survey should be performed after these and other forthcoming strategies have been implemented to assess the impact of these programs.

#### PUBLIC HEALTH IMPLICATIONS

Preventing pregnancy until it is desired enables women to address medical, behavioral, and social risks and improves outcomes. Reproductive life plans, systematic inquiry about pregnancy intent, and LARC counseling can be incorporated into encounters with women to identify needed reproductive health services, reduce unintended pregnancies, and promote optimal women's health before and between pregnancies. Health workers in Ohio need additional education about these practices which can help to reduce the barriers to use. Solutions to barriers such as insufficient knowledge of LARC and ability to educate patients on reproductive life plans need to be developed and implemented at local and state levels.

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## **RESEARCH ARTICLE**

#### Suicide Rates in Rural Ohio: The Role of Population Density, Social Association, and Healthcare Access

Jared A. Embree, MA<sup>1</sup>; Timothy N. Crawford, PhD, MPH<sup>2</sup>; Sara J. Paton, PhD<sup>2</sup>

<sup>1</sup>Substance Abuse Resources & Disability Issues, Wright State University, Dayton, OH

<sup>2</sup>Population and Public Health Sciences, Wright State University, Dayton, OH

Corresponding Author: Jared A. Embree • 3171 Research Blvd, Room 106 Kettering Ohio, 45420 • 937-765-2140 • jared.embree@wright.edu

#### ABSTRACT

**Background:** This study explores differences between adult suicide rates in counties in Ohio from 2007-2016, specifically differences between urban and rural counties. Nationally, the least densely populated states in the nation have the highest rates of completed suicide, and that same trend was hypothesized to exist in the least densely populated counties in Ohio.

Methods: Simple demographics and rates for sub-populations and counties were retrieved for adults over 18 years of age, and separated by rural and urban counties. A random effects meta-regression model was developed to assess the association among suicide death rate, rate of emergency rooms, rate of mental health providers, rate of social associations, and rural or urban counties.

**Results:** There were differences in suicide rate between urban and rural counties. Suicide death rates were significantly associated with rate of mental health facilities, rate of social associations, and type of county (e.g., rural versus urban). As the rate of mental health providers increased, there was a significant decrease in the rate of suicide deaths.

**Conclusions:** This study illustrates the positive effect that access to mental health service providers can have on decreasing suicides in rural areas. More studies are needed focusing on unmet needs in rural areas, specifically those looking at individual level predictors of suicide.

Key words: Suicide, Population Density, Social Association, Mental Health, and Rural

(doi number goes here)

#### INTRODUCTION

Suicide rates in rural areas are an understudied public health issue, particularly in areas far from urban centers. In recent years, this phenomenon was studied internationally,<sup>1,2</sup> and is an area of growing interest for suicidologists. At the macro level in the United States, the problem is most glaring in the most remote parts of Wyoming and Montana and practically inaccessible corners of Alaska. These states have higher suicide rates than the rest of the nation and lower population densities.<sup>3</sup> However, rates similar to these are found in the rural Midwest as well. Nationally, states with lower population densities tend toward higher rates of suicide than more populous states,<sup>3</sup> and we hypothesized that same trend would exist in Ohio counties with lower population densities. This study examines differences in suicide rates by county in Ohio from 2007-2016, specifically differences in adult rates of suicide between urban and rural counties. Other factors explored include demographic differences, availability of emergency medical services, and access to mental health treatment providers and social associations. Our intention was to explore different demographic and population factors associated with completed suicides in the state of Ohio and suggest what directions future research might take in further analyzing the relationship between those differences.

Suicide is the tenth leading cause of death in the United States.<sup>4</sup> For the purpose of this study, suicide is defined as a form of intentional self-directed violence resulting in death. Suicide rates in the United States are currently the highest they have been in three decades, with a climbing trend in recent years.<sup>5</sup> Suicide was the cause of more than 40,000 deaths in 2013, with a rate of 12.7 per 100,000 people.<sup>6</sup> Completed suicides are part of a larger pattern of suicidal behavior that includes suicidal ideation, at-

tempts, and completed suicide. We use the term "completed" as a conscious step away from moral models of understanding the behavior (e.g. "committing" suicide). Intuitively these actions are often understood as a progression with completed suicide the result of ideation and attempts. However, it is important to distinguish between them, and understand that these three behaviors are not necessarily causally ordered.<sup>7,8</sup> There is contention among suicidologists, with some arguing that regardless of differences, these behaviors are etiologically similar.<sup>9</sup> Commonly accepted risk indicators do not precede many completed suicides, and attempts are 10-25 times more common than completed suicides in the United States,<sup>10</sup> making suicides rare compared to the population that would seem to be at risk. These factors combined with the likelihood of underreporting, make this area of study as complex and varied as the people whose lives are being affected. This complexity is further exacerbated by the scarcity of national data on non-fatal behaviors and the difficulty of obtaining complete and accurate data after a suicide.4

Suicidologists traditionally look to a lack of social connectedness as one way to explain suicides in isolated populations. The study of suicide as a sociological phenomenon is relatively recent, starting with Durkheim's work in France.<sup>4,11</sup> From these early studies, several ideas explaining suicide formed, and they drive our modern understanding to the present day. While Durkheim described suicides as "anomic, altruistic, fatalistic, or egoist,"<sup>11</sup> it is this last idea that is of interest most often in studies of rural suicide.<sup>12,13,14</sup> At the macro level, egoistic suicides are a consequence of weak social bonds, occurring when there is a lack of social connectedness.<sup>15</sup> Researchers are now looking more closely at individual level indicators of isolation, in addition to macro-level factor explanations to explain suicidal behaviors.<sup>9</sup> This meso-level study uses population density as an indicator of isolation in a general way, and bridges the gap between studies that focus on the individual or the society as a whole. This is a conscious step away from Durkheim's egoist explanation, and points to a need for alternative explanations of those differences in suicide rates in rural areas, and suggests that a lack of access to care may explain more of that difference than a lack of social connectedness. In addition to population density this study explores social associations at the county level as an indicator of isolation, and a lack of access to care, both of which can be consequences of living in rural areas. Population density is not the only factor to consider, but it may be the driving force behind other factors that contribute to increased rates of suicide in rural areas.<sup>16</sup> This isolation from services and support impacts the entire population of a rural county and differences in suicides rates may be but one aspect of a larger problem.

As one considers the differences between rural and urban settings, pertaining to suicide, the simple lack of other people in large numbers would lead to concerns that developing social connectedness could be difficult. Fewer people in general can mean fewer people with whom to connect and a decreased chance of finding a person with whom to develop meaningful social associations and bonds. Nevertheless, humans have connected socially in small groups for thousands of years and other forces must be at play to explain the differences completely. This is further complicated because assessing that connectedness is difficult after death. However, another area of connectedness exists in a more formalized manner that can be measured. Availability of mental health treatment and emergency room services may have a more direct bearing on a person's access to support. In the case of mental health services, a person at risk who is many miles away from the nearest service provider, living in an area where the number of such providers is low, has fewer opportunities to access such services.<sup>6,17,18</sup> Similarly, proximity to emergency medical services plays a role in the lethality of methods, making methods more lethal in rural areas when that method might be non-lethal in an urban setting.

Typically suicide is explained from the standpoint of the individual; however, this study examines differences between the rates of suicide in counties in Ohio and how those differences affect those counties' access and availability of services for members of their communities. If these differences can more accurately predict changes in suicide rates, then future studies can explore how the idea of isolation may be simply masking a public health service shortcoming. More equitably providing services in rural areas, rather than pointing to individual pressures could relieve such shortcomings.

Commonly accepted risk factors (social isolation, abuse or other trauma, alcohol or drug abuse, anxiety, and depression) precede some completed suicides,<sup>4,10,19,20,21</sup> and represent areas that must be considered when exploring differences between counties. Early access to mental health services is important for more than suicide prevention and is often a challenge in rural areas.<sup>16,22</sup> Access to emergency medical services is also important for all members of a community, and the distance from that care can be the difference between an attempt and a completed suicide, depending on the method of the attempt. Some methods are more lethally reliable (e.g. firearms)<sup>13,14,23</sup> and proximity to emergency medical care is less of a mitigating factor when compared with methods that take comparatively longer to be fatal (e.g. overdose). Although accounting for all of these factors at the county level is beyond the scope of this study, these factors remain an import part of understanding the complexity of the problem.

#### Methods

#### Setting

This study focuses specifically on rates of suicide by adults in the state of Ohio from 2007-2016. Due to the low total number of suicides in areas with very low populations, a period of ten years was chosen in order to retrieve stable suicide rates for all 88 counties in Ohio. Counties were classified as urban or rural using the 2013 Rural-Urban Continuum Codes (RUCC).<sup>24</sup> These Codes form a classification scheme that distinguishes metropolitan (urban) counties by the population size of their metro area, and nonmetropolitan (rural) counties by degree of urbanization and adjacency to a metro area or areas.

#### Design

This is an ecological study of death by suicide. This meso-level study uses population density, social association, and access to mental-health providers to explore differences in suicide rates in rural and urban counties. This is a secondary data analysis using county-level data collected for 2007-2016, from the Ohio Public Health Data Warehouse.<sup>25</sup>

#### Participants

Ohio county-level data were retrieved for suicide deaths for the years 2007-2016, and included adults 18 years of age or older. Population data for 2005-2009 was retrieved from Ohio Public Health Data Warehouse<sup>25</sup> (OPHDW) July 1, 2005 - July 1 2009: Revised Bridged-Race Intercensal Population Estimates (released 6/26/2014). Population data for 2010-2016 was retrieved from OPHDW<sup>25</sup> July 1, 2010 - July 1, 2016: Vintage 2016 Bridged-Race Postcensal Population Estimates (released 6/26/2017).

#### Procedures

Demographic data for suicides in Ohio were retrieved from the OPHDW query system, by selecting for cause of death and demographics (sex, age, marital status, and race).<sup>25</sup> State suicide data were analyzed for differences in demographics and variation in suicide rates compared to population density. Cause of suicide death rates by urban/rural county were retrieved from the Center for Disease Control and Prevention (CDC) WONDER Online Database.<sup>26</sup> Cause of death was queried using the International Classification of Diseases, Tenth Revision (ICD-10) codes for suicide. ICD-10 codes for suicide included X60-X84 and Y87. Codes with less than 10 deaths were suppressed by CDC Wonder and are grouped together as "other unspecified means."

Suicide rates were calculated in aggregate for all years to increase sample size ( $n \ge 20$ ) for counties with smaller populations, and population density for each county was calculated based on 2010 US Census data Suicide rates were mapped by county using ArcGIS 10.5. All data used in the study is publicly available and can be accessed by anyone interested in conducting similar analyses in this area for other states.

#### Measures/Outcomes

Descriptive statistics were retrieved and summarized to describe the study population, with frequencies and percentages for all categorical variables and means for all continuous variables Suicide rates were calculated per 100,000. Variables used in descriptive statistics included sex, age, marital status, and race.

For the meta-analysis model, the following variables were included; access to emergency medical treatment, rate of social associations, mental health provider rate, and rural/urban county. Access to emergency medical treatment in each county includes hospitals and stand-alone emergency rooms. The rate of social associations per county was retrieved from the Robert Wood Johnson's County Ranking website.<sup>27</sup> Social association rate is defined as the number of membership associations per 10,000. Mental health provider rate by county was also retrieved from Robert Wood Johnson's County Ranking website.<sup>28</sup> Mental health provider rate is the ratio of the county population to the number of mental health providers including psychiatrists, psychologists, licensed clinical social workers, counselors, marriage and family therapists, mental health providers that treat alcohol and other drug abuse, and advanced practice nurses specializing in mental health care. Counties were classified as urban or rural using the 2013 RUCC.

#### **Statistical Analysis**

To examine associations between suicide death rates and county level variables, meta-analysis techniques were used. A random effects meta-regression model was developed to assess an association among suicide death rate, rate of emergency rooms, rate of mental health providers, rate of social associations, and rural or urban counties. The meta-regression was conducted using SAS version 9.4 (Cary, NC) and p-values <.05 were regarded as statistically significant.

#### Institutional Review Board Approval

Although no institutional review board (IRB) approval is required for secondary data research conducted on deceased persons, all identifiable information was safeguarded and every reasonable precaution was taken to maintain the security of the data, as well as ensure respectful treatment commensurate with the seriousness of the subject matter.

#### Results

Between January 1, 2007 and December 31, 2016, there were 14,885 completed suicides among Ohio residents. After data cleaning, there were 14,353 completed suicides by adults used in this study (Table 1). The average age among this aggregate group was 47.4 years (SD = 17.38; range = 18 to 101). The group is disproportionately male (79.6%, n = 11,423) with female completed suicides accounting for only 20.4% (n = 2,930). The largest numbers of suicides were by those between the ages of 45 and 54 (n = 3,166), comprising 22.1% of the sample. Those from the ages of 18 to 24 (n = 1,489) had the smallest numbers of suicides (10.4%). Within these age groups, the largest numbers of suicides were by adult males between the ages of 45 and 54 (n = 2,381),

<b>Table 1:</b> Demographics of Suicide Deaths in Ohio, 2007-2016 (N = 14,353) <sup>a</sup>							
	Urban	Rural	Total				
Sex							
Male	79% (n = 8,898)	81.8% (n = 2,525)	79.6% (n = 11,423)				
Female	21% (n = 2,370)	18.2% (n = 560)	20.4% (n = 2,930)				
Age							
18 to 24	10.5% (n =1,179)	10% (n = 310)	10.4% (n = 1,489)				
25 to 34	16.8% (n = 1,888)	15.3% (n = 472)	16.4% (n = 2,360)				
35 to 44	17.9% (n = 2,572)	18% (n = 555)	17.9% (n = 2,572)				
45 to 54	22.2% (n = 2,501)	21.6% (n = 665)	22.1% (n = 3,166)				
55 to 64	17.1% (n = 1,927)	15.6% (n = 482)	16.8% (n = 2,409)				
65 and older	15.6% (n = 1,756)	19.5% (n = 601)	16.4% (n = 2,357)				
Marital Status							
Separated	0.8% (n =93)	1.3% (n = 39)	0.9% (n = 132)				
Single	34.5% (n = 3,892)	27.4% (n = 846)	33% (n = 4,738)				
Married	34.4% (n = 3,878)	39.8% (n = 1,227)	35.6% (n = 5,105)				
Divorced	22.7% (n = 2,553)	22.7% (n = 700)	22.7% (n = 3,253)				
Widowed	6.5% (n = 737)	7.8% (n = 240)	6.8% (n = 977)				
Unknown	1% (n = 115)	1.1% (n = 33)	1% (n = 148)				
Race							
White	90.5% (n = 10,194)	98.1% (n = 3,025)	92.1% (n = 13,219)				
Black	7.8% (n = 881)	1.6% (n = 49)	6.5% (n = 930)				
Asian	0.1% (n = 13)	0.1% (n = 3)	0.1% (n = 16)				
Other	1.1% (n = 129)	0.2% (n = 6)	0.9% (n = 135)				
Unknown	0.5% (n = 51)	0.1% (n = 2)	0.4% (n = 53)				

or 16.6% of the sample. Women between the ages of 18 to 24 (n = 243) had the smallest numbers of suicides, representing only 1.7%. Suicides by those aged 65 and older (n = 2,357) represented 16.4% of overall suicides and showed the greatest differences between rural (19.5%, n = 601) and urban (15.6%, n = 1,756) suicides.

Of the total population of adult suicides, 6.5% (n = 930) were African American and 92.1% (n = 13,219) were Caucasian. All other races combined accounted for 1% (n = 151) of the completed suicides, with Asian/Pacific Islanders (n = 16) making up less than one percent of the sample in the next largest category. Other racial and ethnic groups were even less represented in the sample. African American suicides in rural counties showed the greatest differences between rural (1.6%, n = 930) and urban (7.8%, n = 881) suicides, compared to other races. Of the total population of adult suicides, 35.6% (n = 5,105) were married, 33% (n = 4,738) were single, and 22.7% (n = 3,253) were divorced.

The most common causes of death are listed in Table 2, and broken down by ICD-10 code, separated by rural and urban counties. The leading cause of death was firearm injury (handgun, rifle, shotgun, or unspecified), accounting for 51.5% (n = 7,390) of all suicides, followed by hanging, strangulation, or suffocation accounting for 25.2% (n = 3,613). Drug and alcohol overdose was the cause of death for 12.4% (n = 1,775) of suicides.

#### Table 2: Cause of Suicide Deaths in Ohio, 2007-2016 (N = 14,353) Cause Urban Rural Total 244% Antiepileptic, sedative-hypnotic, 139% 2 2 2 % (n = 318) antiparkinsonism, and psychotropic (n = 275)(n = 43)0.45% 0.42% 0.45% Crashing of motor vehicle (n = 51) (n = 13) (n = 64) 0.75% 0.42% 0.72% Drowning and submersion (n = 85)(n = 13)(n = 104) 4.83% 5.87% 5.05% Handgun (n = 544)(n = 181) (n = 725) Hanging, strangulation 25 43% 24.21% 2517% and suffocation (n = 2.866) (n = 747)(n = 3.613)185% 0.55% 157% Jumping from a high place (n = 208)(n = 225)(n = 17)Jumping or lying before 0.81% 0.97% 0.84% moving object (n = 91)(n = 30) (n = 121) Narcotics and psychodysleptics 1.43% 1.33% 1.41% (hallucinogens) (n = 202) (n = 161) (n = 41)Non-opioid analgesics, antipyretics, 0.39% 0.36% 0.38% and antirheumatics (n = 44)(n = 11)(n = 55)Organic solvents and halogenated 0 41% 0.23% 0.37% hydrocarbons and their vapors (n = 46)(n = 7)(n = 53) 7.03% Other and unspecified drugs medicants 8.56% 8.23% and biological substances (n = 964)(n = 217)(n = 1,181)4.01% 285% 376% Other gases and vapors (n = 452)(n = 88) (n = 540)0.33% 0.39% 0.34% Other Specified Means (n = 49) (n =37) (n = 12)0.42% 0.36% 0.40% Other Unspecified Means (n = 47)(n = 11)(n = 58) 6.97% 5.19% 5.57% Rifle, Shotgun, or Larger (n = 585)(n = 215) (n = 800) 1.74% 0.91% 1.56% Sharp object (n = 196) (n = 28)(n = 224) 0.41% 0.52% 043% Smoke, fire and flames (n = 46)(n = 16)(n = 62)44.47% 40.86% 39.87% Unspecified firearm/gun (n = 4,493) (n = 1,372) (n = 5,865)

<sup>a</sup>2007-2016 CDC WONDER Online Database<sup>26</sup>

<sup>a</sup>2007-2016 Ohio Public Health Data Warehouse<sup>25</sup>





<sup>a</sup>2007-2016 Ohio Public Health Data Warehouse<sup>25</sup>

Ohio's suicide rate, based on the aggregate of data from 2007-2016, showed a rate of 12.4 per 100,000. The rate for adult males overall was 19.7 per 100,000 and the rate for adult females was 4.7 per 100,000. Calculated rates for 88 counties in Ohio showed differences between population density and suicide rate (Figure 1). Of the three most densely populated counties (Cuyahoga, Franklin, and Hamilton) that make up the core of Ohio's three urban centers, all showed suicide rates below the average for the state (12.4 per 100,000) as well as below that of the nation (13.0 per 100,000) aggregated across the same years. Cuyahoga County had a rate of 11.0 per 100,000, Franklin County had a rate of 11.3 per 100,000, and Hamilton County had a rate of 11.6 per 100,000. In contrast to Ohio's major metropolitan areas, eight of the ten counties with the highest suicide rates in Ohio were rural counties with rates ranging from 17.4 per 100.000 in Columbiana County to 19.8 per 100,000 in Adams County.

The results of the meta-regression are presented in Table 3. Suicide death rates were significantly associated with rate of mental health facilities, rate of social associations, and type of county (e.g., rural versus urban). As the rate of mental health facilities increased, there was a significant decrease in the rate of suicide deaths (b = -0.005;  $\beta$  = -0.19; z = -2.24; p = .03). While controlling for the other variables in the regression model, the rate of suicide deaths was lower for rural counties compared to urban counties  $(b = -0.88; \beta = -0.19; z = -2.58; p = .01).$ 

<b>Table 3:</b> Meta Regression to Examine Associations with Rate of Suicide Death (N = 88)								
Variables b SE B z p								
Emergency Rooms	-0.017	0.03	-0.04	-0.52	.60			
MHP Ratea	-0.005	0.002	-0.19	-2.24	.03			
SA Rateb	0.167	0.05	0.22	3.20	.001			
Rural versus Urban County	-0.881	0.34	-0.19	-2.58	.01			

<sup>a</sup>Mental Health Providers

<sup>b</sup>Social Associations Rate

#### Discussion

The intention of this study was to explore different demographic and population factors associated with completed suicides in the state of Ohio and suggest what directions future research might take in further analyzing the relationship between those differences. Suicide rates are slowly rising in the United States. Ohio is very close to the national rate of 13.0 per 100,000, with a suicide rate of 12.4 per 100,000 in this population, and is among the middle states when ranked by age-adjusted suicide rate. Although less racially and ethnically diverse than some other states, Ohio is reasonably similar to much of the nation in other demographic areas.

The population in this sample in particular is appealing for a number of reasons. First, from a demographic standpoint, the makeup of the suicide deaths is roughly comparable to the state of Ohio as a whole, with the exception of the disproportionately large number of male suicides. The average age of adult men and women in the sample (46.9 years and 46.4 years respectively) and distribution by age group is generally representative of the age demographics for adults in Ohio overall. Racially, the sample is somewhat skewed. There are more Caucasian cases than one might expect in Ohio, but this is not surprising when compared with suicide statistics for the United States as a whole. The differences are exaggerated when comparing urban and rural suicides by race, but this too is the result of the demographic makeup of these areas.

The differences between suicide rates in Ohio's most densely populated counties and the rates in many of the most rural counties in the state show patterns similar to those identified by suicidologists looking at state level data.<sup>3</sup> However, after controlling for the rate of mental health providers, the rate of social associations, and urbanity, the expected result (higher population density resulting in lower suicide rates) was reversed. Most interesting of the factors explored is the effect of mental health service provider rates on suicide rates. The increase in number of mental health providers per person in a county was significantly associated with the rate of suicide deaths reported in that county. Access to mental health services in the form of counseling, self-help groups, and psychiatric care are all more limited in rural areas, if they are available at all, and attitudes toward such services are sometimes culturally different for rural populations compared to those in urban areas.<sup>4</sup> Access to alcohol and drug abuse treatment services and support groups can also be lacking in rural areas. Increased rates of substance use disorder can compound the likelihood of a suicide attempt when paired with mental illness.<sup>27</sup> While caution must be exercised before drawing conclusions about the individual reasons behind these changes based on such data, it does suggest that more attention to preventative mental health screenings and services in rural areas would be worthwhile.

Access to firearms is a recurring theme in suicide research, <sup>3,4,13,14</sup>, and one that is more complex than can be satisfactorily explored with existing data, but must be explored to fully understand the problem, particularly in rural areas. In the case of suicides completed with firearms, which make up the overwhelming majority in this study as well as the rest of the United States,<sup>14</sup> the question of access is of interest but difficult to accurately assess. The number of registered firearms is not necessarily a good indicator of the number of firearms in the county, and basing an analysis on that figure would almost certainly underrepresent the actual total as generations of owners passing weapons to relatives and unregistered new purchases would be left out. Even if such figures were available, they would only address ownership and fail to address the real question of access.<sup>3</sup> Some studies have used other indicators (number of concealed carry permits, number of firearms dealers, etc.) to estimate access to firearms with similar shortcomings.13,23

Since Durkheim wrote Le Suicide, there have been criticisms about drawing conclusions about individual motivations from large group data relating to suicide, and justifiably so. This study points to a need for alternative explanations (stepping away from egoist explanations) of those differences in suicide rates in rural areas, and suggests that a lack of access to care may explain more of that difference than a lack of social connectedness. Suicidal behavior is complex and influenced by motivations too numerous to address here, but it is understood that there are differences in rates of completed suicide in very rural areas. More analysis with robust methods is needed, as is more complete data related to factors known to be associated with suicide.

#### Limitations

The first limitation of this study is that we are not looking at individual level indicators of isolation and are not able to accurately measure that isolation after a suicide. Second, some factors are notoriously difficult to study, as is the case with access to firearms and the lethal reliability that goes with them as a means to committing suicide. Third, and perhaps most problematic, is the reliability of correctly identifying a death as a suicide. Lastly, the reliability and completeness of existing data on completed suicide is an issue. Missing data is one of many factors contributing to the possibility of underreporting completed suicides. Many deaths determined to be accidental for lack of evidence pointing to suicidal intent or to spare relatives from perceived stigma and shame associated with suicide in rural areas may result in under-representative data.

Despite these limitations, the increased rates of completed suicides in rural areas are a reality that remains largely unstudied and unaddressed in the United States. While these disparities are most glaring in nearly inaccessible corners of Alaska and very remote areas of Montana and Wyoming, the three states with the lowest population densities and highest suicide rates, they can be found much closer to large metropolitan areas in the Midwest. The farmland of northern Ohio and the rolling hills of the Appalachian plateau are far from blank spots on the map, and yet they share this similarity with the most isolated parts of the United States.

#### Public Health Implications

Suicide rates in the United States are at their highest levels in three decades, and have been climbing in recent years.<sup>5</sup> Understanding this health risk and how rates differ across Ohio is important to determining how to distribute resources and direct attention to different parts of the state. Findings from this paper indicate that Ohioans in rural areas are more likely to die by suicide than those in urban areas. However, results from this paper also illustrate the positive effect that access to mental health service providers can have on decreasing suicide rates in rural areas, as well as the populations most at risk in those areas.

Delivering mental health services to rural areas efficiently and effectively presents many challenges, and innovative methods may be needed to increase access to for these populations.<sup>28</sup> Telehealth delivery systems and in-home treatment offer some promise for populations open to that type of service,<sup>22</sup> but more research in this area is needed. A lack of access to care is an addressable public health issue, and this research suggests that it may explain more of the differences in suicide rates in rural Ohio counties than an individual's isolation alone. Research looking at individual level predictors of suicide related to access to care and other demographic factors is also needed to more completely understand the problem.

As more than half of those who completed suicides in the state of Ohio from 2007-2016 had access to a firearm at the time of their death, more research into access to firearms is needed. Gathering information of this type has been difficult in recent decades due to funding issues and legislation like the Dickey amendment,<sup>31</sup> but is increasingly becoming a priority for organizations like the CDC and the American Public Health Associations. As more research becomes available and the nature of the problem can be understood more completely, researchers will be able to address access to firearms as a lethal means of suicide more accurately.

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## **RESEARCH ARTICLE**

#### Validation of the exercise self-efficacy scale (ESE-S) for increased adherence to physical activity

Rachael D. Nolan, PhD<sup>1</sup> and Jeffrey S. Hallam, PhD<sup>1</sup>

<sup>1</sup>College of Public Health, Kent State University, Kent, OH

Corresponding Author: Dr. Rachael D. Nolan • 800 Hilltop Drive • Kent, Ohio 44242 • (330) 672-6500 • rnolan1@kent.edu

#### ABSTRACT

**Background:** Various self-efficacy instruments have been used to predict exercise behavior. Many of these scales have been shown to be valid and reliable measures for the strength dimension of self-efficacy, but have overlooked the construct's dimensions of magnitude and generality. This study established the Exercise Self-Efficacy Scale (ESE-S), a measure of the strength, generality, and magnitude dimensions of exercise self-efficacy, as a valid tool towards the promotion and adherence of routine physical activity.

Methods: Using a non-experimental, cross-sectional design, the ESE-S was administered to individuals aged 18 and older (n=270) who were conveniently recruited from a large city located in Ohio. Participants were employees of a large, national company and consented to participate in an employee wellness campaign over a two-day period. Participants completed the 24-item ESE-S onetime and demographic data were not collected. Confirmatory factor analysis was used to examine the 4-factor hypothesized structure of the ESE-S.

**Results:** The confirmatory analysis showed that the data did not conform to the factorial structure as originally hypothesized, but did retain a 4-four factor solution. Final factors identified from the confirmatory analysis were internal strength, external strength, generality, and magnitude.

**Conclusions:** This study confirmed a 4-factor, 21-item factorial structure. Although the structure differed from that hypothesized, the results showed that the tool was a valid and reliable instrument to measure the dimensions of exercise self-efficacy commonly overlooked within the literature. Public health professionals and researchers can use the instrument to measure exercise self-efficacy and develop self-efficacy based exercise promotion programs.

Key words: Exercise, self-efficacy, confirmatory factor analysis, physical activity

(doi number goes here)

#### INTRODUCTION

Physical activity and exercise can improve overall health including preventing and managing chronic disease. Moreover, engaging in exercise behavior can help control body weight and improve the quality and length of life. In Ohio, 74% of adults report engaging in any exercise in the past 30 days; however, only about 19% meet the physical activity guidelines.<sup>1</sup> Given this low percentage of Ohioans that meet the guidelines, there is a need to develop exercise behavior programs the promote physical activity. Developing effective and efficient theory-based exercise behavior programs is a key public health function.

Self-efficacy is one of the most identified psychosocial determinants of adherence to exercise behavior and routine physical activity. Self-efficacy is defined as an individual's perceived confidence to engage in a particular task.<sup>2</sup> Self-efficacy is not regarded as a construct of one's personal skillset to perform a behavior; rather it is associated with one's individually held beliefs as to whether he or she was able to accomplish a specific behavioral task.<sup>3</sup> For example, with decreased self-efficacy, low expectations regarding routine physical activity often led to avoidance of exercise behaviors; whereas, with increased self-efficacy, high expectations had the potential to lead to increased exercise behavior over time. Given this explanation, exercise self-efficacy had the capacity to explain why exercise behavior and routine physical activity differed widely among individuals, even those with similar knowledge and skillset.<sup>4</sup>

The role of self-efficacy to predict behavioral change with regard to routine physical activity and exercise has been studied by

many.<sup>5-11</sup> From this research, three key dimensions of exercise self-efficacy have been established as magnitude, generality, and strength.<sup>10</sup> The first dimension of magnitude refers to the level of task difficulty within the domain of physical performance, when higher self-efficacy reflects the undertaking of a more difficult task.<sup>2,10</sup> The second dimension, known as generality, signifies the wide range of physical activities that necessitates self-efficacy. Generality also reflects to what extent an individual applies his or her perceived level of self-confidence to complete various tasks associated with routine exercise.<sup>2,10</sup> Lastly, the strength dimension represents the degree to which a person's self-efficacy could withstand setbacks or barriers associated with routine exercise, and still persists despite great difficulty with physical activity performance.<sup>2,10</sup> Based on these three established dimensions found to be predictive of exercise behavioral change, a 24-item self-report instrument was developed known as the Exercise Self-Efficacy Scale (ESE-S).

Developed in 1995, the original ESE-S instrument<sup>10</sup> was subjected to exploratory factor with promax rotation using a convenience sample of self-identified service-industry employees (n=380) aged 18 and older recruited from a large city located in Ohio. The purpose of exploratory factor analysis was to establish the psychometric properties on the ESE-S. The average age of the sample was 38 years, of whom 52% were women and most (55%) had completed a college degree. Based on previous work by Stevens,<sup>12</sup> items in the exploratory model were significant for item-to-factor loadings of  $\geq$ 0.50 specified at the p<0.01 level (Table 1). Internal consistency was assessed with Cronbach alpha ( $\alpha$ >.70) to indicate a reliable measure.<sup>13</sup> The four factors identified through the exploratory analysis that accounted for 16.6% of the variance were strength in the face of barriers (14-items); magnitude of exercise intensity (4-items); generality for free-living exercise (3-items); and generality for structure-dependent exercise (3-items). Factor and item definitions are presented in Table 2. Internal consistency of the original 24-item instrument and its associated subscales was acceptable, resulting in Cronbach alpha between 0.78 and 0.95. The aim of the present study was to use the validated ESE-S tool to confirm the instrument's internal structure and validate its 4-factor solution.

	Table 1. Original (Exploratory) 24-Item Exercise Self-Efficacy Scale Factor Loading*							
					Strength	Magnitude	Generality	Generality
No.	ltem	Item Description	Factor	Variance Explained	In the Face of Barriers	Exercise Intensity	Free Living Mode	Structure Dependent Mode
1	Goals	Exercise when I haven't reached my exercise goal	1	6.83%	0.59			
2	Family	Exercise when I don't receive support from my family or friends			0.53			
3	Ex. w/no-one	Exercise when I have no one to exercise with			0.62			
4	Enjoy	Exercise when my exercise workout is not enjoyable			0.59			
5	Hectic	Exercise when my schedule is hectic			0.78			
6	Depressed	Exercise when feeling depressed			0.69			
7	Crisis	Exercise during or following a personal crisis			0.74			
8	Tired	Exercise when tired			0.82			
9	Anxious	Exercise when feeling anxious			0.59			
10	Weather	Exercise during bad weather			0.65			
11	Sore	Exercise when slightly sore from last time I exercised			0.54			
12	Vacation	Exercise when on vacation			0.68			
13	Compete	Exercise when there are competing interests (like my favorite TV show)			0.71			
14	Work	Exercise when I have a lot of work to do			0.80			
15	Very Light	Exercise very lightly three times a week for the next six months	2	3.83%		0.77		
16	Light	Exercise lightly three times a week for the next six months				0.79		
17	Moderate	Exercise moderately three times a week for the next six months				0.74		
18	Vigorous	Exercise vigorously three times a week for the next six months				0.53		
19	Walk	Walk three times a week for the next six months	3	3.29%			0.56	
20	Run	Run three times a week for the next six months					0.79	
21	Active	Play active sports three times a week for the next six months					0.64	
22	Weights	Use weight training equipment three times a week for the next six months	4	2.69%				0.54
23	Swim	Swim three times a week for the next six months						0.70
24	Aerobic	Participate in aerobic activity three times a week for the next six months						0.73

\*Extraction method: Exploratory principal axis factoring with a promax rotation. Items <0.50 were suppressed.

Table 2. Original (Exploratory) 24-Item Exercise Self-Efficacy Scale Factor and Item Descriptions						
No.	Item	Description	Cronbach's α			
Facto	or One (14-items) Str	ength in the Face of Barriers: defined as the level of perceived confidence to exercise in the face of disconfirming evidence or barriers.	0.95			
1	Goals	Exercise when I haven't reached my exercise goal				
2	Family	Exercise when I don't receive support from my family or friends				
3	Ex. w/no-one	Exercise when I have no one to exercise with				
4	Enjoy	Exercise when my exercise workout is not enjoyable				
5	Hectic	Exercise when my schedule is hectic				
6	Depressed	Exercise when feeling depressed				
7	Crisis	Exercise during or following a personal crisis				
8	Tired	Exercise when tired				
9	Anxious	Exercise when feeling anxious				
10	Weather	Exercise during bad weather				
11	Sore	Exercise when slightly sore from last time I exercised				
12	Vacation	Exercise when on vacation				
13	Compete	Exercise when there are competing interests (like my favorite TV show)				
14	Work	Exercise when I have a lot of work to do				
Facto	or Two (4-items) Mag	gnitude of Exercise Intensity: defined as the level of perceived confidence to exercise across a wide range of task difficulty and intensity.	0.86			
15	Very Light	Exercise very lightly three times a week for the next six months				
16	Light	Exercise lightly three times a week for the next six months				
17	Moderate	Exercise moderately three times a week for the next six months				
18	Vigorous	Exercise vigorously three times a week for the next six months				
Facto perfo	or Three (3-items) G rm the behavior.	enerality for Free-Living Exercise Mode: defined as the mode of exercise that one does not need a facility or physical equipment to	0.78*			
19	Walk	Walk three times a week for the next six months				
20	Run	Run three times a week for the next six months				
21	Active	Play active sports three times a week for the next six months				
Facto perfo	<b>or Four</b> (3-items) Ge rm the behavior.	nerality for Structure-Dependent Exercise Mode: defined as the mode of exercise that requires a facility or physical equipment to				
22	Weights	Use weight training equipment three times a week for the next six months				
23	Swim	Swim three times a week for the next six months				
24	Aerobic	Participate in aerobic activity three times a week for the next six months				

\*Generality of Exercise Mode(s) provides internal consistency for the combined scales of Free-living and Structure-Dependent Exercise.

#### **METHODS**

#### Setting:

Participants (n=270) were employees of a large (N=7,000), service-type, national company located in Central Ohio who consented to participate in an employee wellness campaign over a two-day period.

#### Design:

Non-experimental, cross-sectional design.

#### Participants and Recruitment:

The paper and pencil ESE-S10 was administered to adults aged 18 and older. Employees who volunteered to participate completed the instrument one time and demographic data were not collected. Although demographic data were not collected, the company's overall demographic characteristics were similar to the sample in the exploratory factor analysis.

#### Procedures:

Participants that agreed to participate were handed the ESE-S and a pencil to complete during the wellness campaign. To ensure anonymity, once the participant completed the ESE-S, the participant put the questionnaire into a common envelope. A university Institutional Review Board approved the study.

#### Measures:

The 24-item Exercise Self-Efficacy Scale (ESE-S).10 The onepage instrument directs participants to rate how confident they are to exercise over the next six months for each item on a scale. The participants rated their confidence on a continuous scale from 0% ("I cannot do it at all") to 100% ("Certain I could do it"). The ESE-S takes approximately five minutes to complete.

#### Statistical Analysis:

*Hypothesized Model.* Using the previously established psychometric properties<sup>9</sup> with the addition of an exercise time-component item (Exercise when I have not exercised for a prolonged period of time), the ESE-S was subjected to a principal axis factoring analysis (SPSS, v17, Chicago, IL) with a varimax rotation and Kaiser normalization14 to confirm the original

4-factor solution<sup>10</sup> in an independent sample (n=270) of adults. Latent variables were allowed to correlate, and all items were modeled to load on their corresponding factors. Regression weights, expected parameters of change, and modification indices received examination for areas of model misfit. Based on previous work by Stevens,<sup>12</sup> items in the final model were significant for item-to-factor loadings of ≥0.50 specified at the p<0.01 level that resulted in eigenvalues greater than 1.0 (Table 3). Internal consistency was assessed Cronbach's alpha at  $\alpha$ >.70 to indicate a reliable measure.<sup>13</sup>

#### RESULTS

Final Model and Fit. Results from the confirmatory factor analysis showed that the data did not conform to the original explorative factorial structure but did confirm the existence of a 21-item, 4-factor solution that accounted for approximately 60.44% of the variance (Table 3). Four items failed to load in the final model that were originally identified through the exploratory factor analysis as: work, vacation (factor-1); vigorous (factor-2); and weights (factor-4). The additional exercise-time component that was added loaded on strength-external barriers. The four factors retained through the confirmatory analysis were interpreted as strength-external barriers (7-items), strength-internal barriers (6-items), magnitude of exercise intensity (3-items), and generality of exercise mode (5-items). Factor and item definitions from the confirmatory analysis are presented in Table 4. Internal consistency for the full measure and its associated subscales was acceptable, resulting in Cronbach's alpha between 0.81 and 0.98.

	Table 3. Final (Confirmatory) 21-Item Exercise Self-Efficacy Scale Factor Loading and Eigenvalues*†							
					Strength	Magnitude	Generality	Generality
No.	Item	Item Description	Factor	Eigenvalue (var. exp**)	External Barriers	Internal Barriers	Exercise Intensity	Exercise Mode
1	Goals	Exercise when I haven't reached my exercise goal	1	10.1	0.66			
2	Family	Exercise when I don't receive support from my family or friends		(40.11%)	0.76			
3	Time	Exercise when I have not exercised for a prolonged period of time			0.72			
4	Ex. w/no-one	Exercise when I have no one to exercise with			0.74			
5	Enjoy	Exercise when my exercise workout is not enjoyable			0.52			
6	Hectic	Exercise when my schedule is hectic			0.52			
7	Compete	Exercise when there are competing interests (like my favorite TV show)			0.56			
8	Depressed	Exercise when feeling depressed	2	2.4		0.73		
9	Crisis	Exercise during or following a personal crisis		(9.87%)		0.73		
10	Tired	Exercise when tired				0.71		
11	Anxious	Exercise when feeling anxious				0.70		
12	Weather	Exercise during bad weather				0.59		
13	Sore	Exercise when slightly sore from last time I exercised				0.51		
14	Very Light	Exercise very lightly three times a week for the next six months	3	1.2			0.91	
15	Light	Exercise lightly three times a week for the next six months		(4.40%)			0.93	
16	Moderate	Exercise moderately three times a week for the next six month					0.77	
17	Walk	Walk three times a week for the next six months	4	1.5				0.57
18	Run	Run three times a week for the next six months		(6.06%)				0.60
19	Active	Play active sports three times a week for the next six months						0.56
20	Swim	Swim three times a week for the next six months						0.78
21	Aerobic	Participate in aerobic activity three times a week for the next six months						0.61

\*Extraction method: Confirmatory principal axis factoring with a varimax rotation and Kaiser normalization. Rotation converged in 7 iterations. Items < 0.50 were suppressed.

\*\*Var. exp is variance explained

\*Items from the exploratory analysis that dropped out in the final model were work, vacation (factor-1); vigorous (factor-2); and weights (factor-4). The additional exercise-time component that was added loaded on strength-external barriers.

	Table 4. Final (Confirmatory) 21-Item Exercise Self-Efficacy Scale Factor and Item Descriptions*						
No.	Item	Description	Cronbach's α				
Facto	or One (7-items) Stre	ength in the Face of External Barriers: defined as the level of perceived confidence to exercise in the face of external barriers.	0.98				
1	Goals	Exercise when I haven't reached my exercise goal					
2	Family	Exercise when I don't receive support from my family or friends					
3	Time	Exercise when I have not exercised for a prolonged period of time					
4	Ex. w/no-one	Exercise when I have no one to exercise with					
5	Enjoy	Exercise when my exercise workout is not enjoyable					
6	Hectic	Exercise when my schedule is hectic					
7	Compete	Exercise when there are competing interests (like my favorite TV show)					
Facto	or Two (6-items) Stre	ength in the Face of Internal Barriers: defined as the level of perceived confidence to exercise in the face of internal barriers.	0.91				
8	Depressed	Exercise when feeling depressed					
9	Crisis	Exercise during or following a personal crisis					
10	Tired	Exercise when tired					
11	Anxious	Exercise when feeling anxious					
12	Weather	Exercise during bad weather					
13	Sore	Exercise when slightly sore from last time I exercised					
Facto	or Three (3-items) Ma	agnitude of Exercise Intensity: defined as the level of perceived confidence to exercise across a wide range of task difficulty and intensity.	0.89				
14	Very Light	Exercise very lightly three times a week for the next six months					
15	Light	Exercise lightly three times a week for the next six months					
16	Moderate	Exercise moderately three times a week for the next six months					
Facto	or Four (5-items) Gei	nerality for Exercise Mode: defined as the various modes of exercise one uses to perform routine physical activity.	0.81				
17	Walk	Walk three times a week for the next six months					
18	Run	Run three times a week for the next six months					
19	Active	Play active sports three times a week for the next six months					
20	Swim	Swim three times a week for the next six months					
21	Aerobic	Participate in aerobic activity three times a week for the next six months					

\*Items from the exploratory analysis dropped out in the final model were work, vacation (factor-1); vigorous (factor-2); and weight (factor-4). The additional exercise-time component loaded on strength-external barriers.

#### DISCUSSION

This study confirmed a 4-factor, 21-item factorial structure of the Exercise Self-Efficacy Scale (ESE-S). Although the confirmed structure differed from that originally hypothesized,<sup>10</sup> the results showed that the ESE-S was a valid and reliable tool to measure the dimensions of exercise self-efficacy commonly overlooked within the literature known as magnitude and generality. This study contributes to the growing body of literature that has demonstrated the need for more valid and reliable measurement on exercise self-efficacy connot be effectively measured as a one-dimensional construct.<sup>2</sup>

The difference in the internal structure of the ESE-S that resulted from the exploratory factor analysis when compared to the confirmatory factor analysis might be partially explained by the unique size and aspects of the two study samples. For instance, in the exploratory analysis, the ESE-S was administered to a sample of self-identified service-industry employees (n=380) aged 18 and older recruited from a large city located in Ohio. Conversely, in the confirmatory analysis, the ESE-S was administered to participants (n=270) identified as employees of a large, national company located in central Ohio. Notwithstanding, it could also be concluded that the difference in the internal structure of the ESE-S could have occurred by chance or error; and that a similar fit between the exploratory and confirmatory models to the data could have been obtained with further revision and testing of the instrument.

Within the final ESE-S measure, all items of magnitude-exercise intensity scale loaded as expected on their respective factor except for vigorous (Exercise vigorously three times a week for the next six months). An explanation as to why this item dropped out of the final model could be that individuals who completed the ESE-S might have associated vigorous exercise with a more moderate intensity of physical activity; or that these individuals did not engage in what they believed to be vigorous activity. For the scales of generality for structure-dependent exercise (exploratory) and generality for free-living exercise (exploratory), all items in the final model loaded on a single factor identified as generality of exercise mode except for the item of weights (Use weight training equipment three times a week for the next six months). Further examination on why this item failed to load revealed that either participants did not engage in this type of activity, or that the physical environment where individuals exercised was not supportive of weight training equipment use.

From the original 14-items believed to represent strength in the face of barriers, all items in the final model loaded on two separate factors identified as strength in the face of external barriers and strength in the face of internal barriers except for the items of work (Exercise when I have a lot of work to do) and vacation (Exercise when on vacation). Additional examination of these scales suggested that personal norms of participants who completed the ESE-S measure may have disconfirmed engagement in exercise during specified periods of work, or while on vacation. More interesting was that the item of weather (Exercise during bad weather) loaded on the strength in the face of internal barriers, which suggested that personal perceptions of weather influenced whether adults engaged in physical activity or routine exercise.

The additional time-component item (Exercise when I have not exercised for a prolonged period), previously excluded from the exploratory analysis, loaded on strength in the face of external barriers. This finding was significant in that it mirrored more recent literature,<sup>15</sup> which has shown that exercise behavior, particularly during high-intensity or high-impact physical activity, can distort one's perception of time. In fact, greater intensity of exercise has been shown to lead to a decreased perception of time, where more time appeared to have passed than what was objectively true.14 Given this notion, time can be perceived as an external source of influence that served to either hinder or support engagement in physical activity based on the level of exertion required. More importantly, an individual must be willing to endure the level of exertion required in order to perform the exercise or routine physical activity for a period of time.<sup>16</sup>

Limitations. Although several methodological strengths existed in the present study, there were some significant limitations that should be taken into consideration. Since participants voluntarily agreed and consented to complete the ESE-S, there was likely to be some degree of self-selection bias. This inherent limitation led to the sample not being fully representative of the adult population who exercised or performed routine physical activity. Convenience sampling methods were used to recruit participants from a geographically proximal population.

#### PUBLIC HEALTH IMPLICATIONS

This study validated the 4-factor. 21-item internal structure of the Exercise Self-Efficacy Scale (ESE-S). Confirmation of the final factors (internal strength, external strength, generality, and magnitude) described in this study explained more of the variance when compared to the original model as hypothesized, and should be further assessed in future investigations. To the extent that identified factors represent underlying causal mechanisms of exercise self-efficacy, the ESE-S held important public health implications regarding the future assessment and predictive ability of the tool to explain exercise behavior. In addition, the ESE-S may be used as a diagnostic tool for commercial- and medical-fitness facilities when designing physical activity programs to address clients' needs. Given the current adult physical activity rates in Ohio<sup>17</sup> and that self-efficacy is the most influential psychosocial variable related to physical activity,<sup>5</sup> there is substantial room to improve physical activity rates in Ohio through effective interventions that target self-efficacy. Through greater use, the ESE-S tool can assist researchers and practitioners measure self-efficacy to design and determine the effectiveness of physical activity interventions.

While there has been a concerted effort to modify the built environment to support physical activity behavior, personal decision making and the psychosocial determinants still play a vital role in promoting physical activity behavior. Both the environment and the person are necessary to change physical activity behavior. In order to facilitate this research and promote clinical advancements in the area of exercise self-efficacy, an empirically sound model and associated factor dimensionality of the ESE-S should be identified. This model must be clinically relevant, easily available to practitioners, and appropriate for diverse populations.

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## **RESEARCH ARTICLE**

## Exploration of provider exercise prescriptions and exercise referrals to place or professional: A pilot survey research study

Carissa Smock, PhD, MPH<sup>1,2</sup>; Sheryl Chatfield, PhD<sup>1</sup>; Lynn Falletta, PhD<sup>1</sup>; Jeffrey S. Hallam, PhD<sup>1</sup>; Sonia Alemagno, PhD<sup>1</sup> <sup>1</sup>Kent State University College of Public Health, Moulton Hall, 800 Hilltop Drive, Kent, OH USA 44242 <sup>2</sup>Northcentral University, San Diego, CA

Corresponding Author: Carissa Smock, PhD, MPH • Northcentral University • 2488 Historic Decatur Rd, San Diego, CA 92106 • csmock@ncu.edu

#### ABSTRACT

**Background:** Physical inactivity contributes to roughly \$28 billion in annual US health care expenditures, although few US-based providers write exercise prescriptions (EPs). Little research has explored the practice of provider referrals to places for exercise as part of an EP or part of general exercise counseling, despite the known relationship between place and health. The purpose of this pilot study, conducted with Northeast Ohio-based providers, was to assess a new instrument designed to explore provider practices related to EP and referral to place and professional.

Methods: The 88-item survey combined standardized and new items to fully address the purpose. Providers were surveyed via paper and online methods. Logistic regression was conducted to explore factors related to referrals to a specific place or exercise professional.

**Results:** Of 166 providers who completed the survey, 14.8% of prescribed exercise to patients and 54.3% referred patients to an exercise professional or specific place. Logistic regression analysis suggested that physicians who prescribed exercise were more likely to provide a referral to professional or place (OR = 6.12, 95% CI = 1.36 - 27.47) while physicians who had accurate knowledge of exercise recommendations were less likely to provide a referral to a professional or place (OR = 0.15, 95% CI = 0.04 - 0.57).

**Conclusions:** A key reason for failure to prescribe place-based exercise referrals was provider unfamiliarity with convenient and safe locations other than health system owned fitness facilities, so provision of exercise location resources for providers potentially will increase use of EPs.

Key words: Exercise prescription; Place; Primary Health Care; Survey research

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#### INTRODUCTION

Physical inactivity contributes to an estimated \$28 billion in annual health care expenditures in the US<sup>1</sup> and is considered a contributing cause to as many as one in ten annual US deaths.<sup>2</sup> Physical inactivity in adults is defined as those who recall no leisure-time physical activity in the past month. The reported percentage of physical inactivity within Ohio is 25.9%, which exceeds the national average of 23.1%.<sup>3</sup>

Exercise prescriptions (EP) are viable, economical, and policy supported-solutions that have potential to decrease global morbidity and mortality<sup>4,5</sup> and are characterized, much like pharmaceutical prescriptions, as having a type and dose, dosing frequency, duration of treatment as a therapeutic goal, and anticipated adverse effects.<sup>6,7</sup> EPs include a specific plan of physical activities that are designed for a specified purpose, which is often developed by a fitness or rehabilitation specialist for the patient.<sup>6,7</sup> Exercise referrals, which might be provided in addition to exercise prescriptions, or as part of general exercise counseling, are characterized by health care providers identifying a specific exercise location or fitness professional as a patient resource.<sup>8,9</sup>

The US, ranked 27th in the world for life expectancy, continues to lag behind other nations in efforts to encourage use of provider-initiated EPs to increase participation in physical activity among patients at risk for chronic disease.<sup>10</sup> The US Office of Disease Prevention and Health Promotion has established and

updated guidelines for physical activity. Recommendations for adults include participating in at least 150 minutes per week of moderate-intensity, or 75 per week of vigorous-intensity aerobic physical activity and at least two days a week of strength training. Children and adolescents should get 60 minutes or more of physical activity daily and strength activities at least three days a week. Older adults and those with chronic illnesses are recommended to be as physically active as their abilities and conditions allow. Older adults are also recommended to do exercises that maintain or improve balance if they are at risk of falling.<sup>11</sup> Although increases in exercise volume have been associated with increases in musculoskeletal injury among women, beneficial effects of exercise, that include improvements in physical and mental health outcomes, counter the relatively low risk of injury associated with regular participation aerobic and strength training activities.<sup>12</sup>

Among US-based providers, it is estimated that only 14% regularly prescribe exercise to roughly half of their patients.<sup>13</sup> By comparison, 60% of Danish physicians<sup>14</sup> and 54% of German physicians<sup>15</sup> reported providing detailed exercise recommendations to many of their patients on a frequent and ongoing basis. US providers have ample opportunity to recommend and prescribe exercise, as the average American accrues 2.<sup>8</sup> physician visits per year, often in association with prevention and treatment of chronic health conditions.<sup>16</sup> Practitioner-reported barriers that deter use of EPs include lack of expertise to appropriately recommend exercise, perceived lack of time to discuss exercise during routine care visits,<sup>17</sup> and lack of available reimbursement for recommended exercise or lifestyle interventions.<sup>18</sup> Association advocates of EPs for US-based physicians include the American Academy of Family Physicians (AAFP),<sup>19</sup> the American College of Physician Services (ACP),<sup>20</sup> the American Academy of Pediatrics (AAP),<sup>21</sup> and the American College of Sports Medicine (ACSM).<sup>22</sup>

Even in countries where EPs are more common, guidance for referral to a suitable place for exercise is not necessarily provided, although place exerts tremendous influence over behavior. Physicians are likely to improve uptake of formal exercise prescription and informal exercise counseling by having knowledge about the environments that are likely to be accessed by patients.<sup>23</sup> Health system owned fitness facilities are at times conveniently located, but regular use of these might be cost prohibitive for some at risk patient populations. Some research suggests that outdoor exercise is perceived as more restorative<sup>24</sup> and is associated with higher levels of self-rated wellbeing,<sup>25</sup> although providers need also be aware of factors that impact patients' access to outdoor spaces such as work schedules, available transportation, location resources, and aspects of actual and/or perceived safety before emphasizing outdoor activity.

Community clinical linkages (CCL) are defined as connections between community and clinical sectors to improve population health. CCLs have potential to facilitate information sharing about potential locations for exercise.<sup>26</sup> CCL processes include varying levels of information and resource sharing, capacity enhancement, and other activities undertaken for mutual benefit and to achieve a common purpose. Clearly, incorporating referral to place or exercise professionals into EPs adds an additional layer of challenge for practitioners. Based on our review of research, this challenge has not been explored in the context of prior assessments of barriers and facilitators of EPs. Therefore, the purpose of this paper is to describe findings from a pilot survey of Ohio-based primary care practitioners designed to assess EP practices and factors associated with provider use of referrals to exercise professionals and specific places for activity.

#### Methods

#### Setting

Data were gathered during September and October of 2016 from participants who were employed by health systems in Northeast Ohio. The Institutional Review Board of Kent State University approved this research study.

#### Design

This research reflects a cross-sectional survey design. Because no existing instrument was identified that combined provider facilitator and barrier information with items exploring use of referrals to professionals or places, the instrument was created using items derived from multiple sources. Items included those that assessed provider practices, attitudes, facilitators, and barriers related to EPs, items about referrals to place or professional, assessment of providers' physical activity practices, and provider responses to training about EPs. The survey consisted of 88 items, mostly fixed response items, with a small number of free response options included to provide detail when an "other" alternative was chosen. The majority of items were scored using a 5 point strongly disagree to strongly agree scale. Average duration to complete the instrument was 10 minutes. Specific details about instrument development including exploratory factor analysis are reported elsewhere.27

#### Participants

Due to the pilot nature of the study, a convenience sample of local providers was identified and contacted. Responses were solicited from 223 primary care physicians and nurse practitioners employed by two Northeast Ohio health systems and 1545 alumni of a Northeast Ohio university nurse practitioner program. To be eligible, participants must provide direct patient care as a physician or nurse practitioner in family or internal practice. A total of 166 responses were received; which reflects a low overall response rate of 9.5%, although 71% of providers within the two hospital systems responded (n = 158 out of 223 provider contacts).

#### Procedures

Questionnaires were administered both electronically and via paper. Respondents were offered incentives in the form of a \$10 coffee gift card through a separate contact process so response information was not associated with incentive contact details.

#### Measure/outcomes

The specific outcome of interest for this study was provision to patients of specific referrals to exercise locations or professionals. Providers were also asked basic demographic information, to describe aspects of their practice and experience, and to provide practice and attitudinal data related to EPs.

#### Statistical analyses

All statistical analyses were conducted with SPSS version 21.<sup>28</sup> Variables were derived from the 88-item questionnaire, available in its entirety through request to the first author. Descriptive analyses were conducted to summarize provider characteristics. We used logistic regression to model to the outcome referral to professional or location. The independent variables included in logistic regression analysis were derived from responses to the following survey items: provider asks patients about exercise; provider documents exercise; provider prescribes exercise; provider demonstrates accurate knowledge of physical activity guidelines; provider believes patient will engage in exercise. Missing data comprised 18.6% of the sample, calculated as: total possible sample size – the missing listwise N)/(total possible sample size).

Table 1: Characteristics and Practices of Surveyed Providers						
Factor	N	%				
Gender (n = 130)						
Male	50	38.5				
Female	80	61.5				
Years practicing (n = 118)						
0 – 4 years	35	29.7				
5 - 14 years	34	28.8				
15 – 24 years	24	20.3				
25 + years	25	21.2				
Specialty (n = 126)						
Family Medicine	26	20.6				
Internal Medicine	35	27.8				
Nurse Practitioner	37	29.4				
Other	28	22.2				
Race (n = 130)						
Black	2	1.5				
Hispanic/Latino	2	1.5				
Asian/Pacific Islander	11	8.5				
White	113	86.9				
Choose not to answer	2	1.5				
Exercise prescription stressed in practice (n = 146)	54	37.0				
Exercise counseling stressed in practice (n = 145)	98	67.6				
Provider asks about patient exercise (n = 149)	132	88.6				
Provider documents patient exercise (n = 146)	91	62.3				
Provider assesses physical fitness (n = 130)	27	20.8				
Provider assesses activity level (n = 130)	109	83.8				
Provider prescribes exercise (n = 132)	21	14.8				
Provide refer to a professional/location (n = 140)	76	54.3				

#### Results

Demographic and practice characteristics of the study sample are shown in Table 1, along with the number of providers who responded to each item. Of responding providers, 37.0% indicated that EPs are stressed within their practice and 67.6% suggested that exercise counseling is stressed within their practice. Only 14.8% of providers responded that they explicitly prescribe exercise to patients, while 54.3% of providers reported giving a place-based exercise referral, either in the context of EP or as part of general exercise counseling.

The logistic regression model included only the 135 cases that included responses to all five variables. In Table 2, we show regression coefficients, Wald statistics, and odds ratios with 95% confidence intervals for each factor. Only provider exercise prescriptions (characterized like pharmaceutical prescriptions including a type and dose, dosing frequency, duration of treatment as a

Table 2: Odds ratios of context-specific provider exercisereferrals to place or professional							
Variable	В	Wald Chi- Square	Odds ratio	Lower 95% Cl	Upper 95% Cl		
Provider asks patients about exercise	1.02	1.79	2.77	0.62	12.31		
Provider documents patient exercise	0.77	2.84	2.15	0.88	5.23		
Provider prescribes exercise	1.81	5.59*	6.12	1.36	27.47		
Provider has knowl- edge of physical activity guidelines	-1.871	7.825**	0.15	0.04	0.57		
Provider believes patient will engage in exercise	0.35	0.09	1.42	0.15	13.93		

\* p< 0.05 \*\* p<0.01

therapeutic goal, anticipated adverse effects, and specific plan of physical activities that are designed for a specified purpose)<sup>6,7</sup>  $\chi^2$  (1, N = 135) = 7.825, p < .01 and providers' knowledge of physical activity guidelines ( $\chi^2$  (1, N = 135) = 5.587, p < .05) significantly predicted provider referral to professional or location. Providers who prescribe exercise have more than 6 times the odds of referral to a place or professional and providers who have knowledge of guidelines have 0.35 times the odds of referral.

#### Discussion

The purpose of this pilot survey of Ohio-based primary care practitioners was designed to assess factors associated with EP practices with particular focus on provider use of referrals to professionals and places for exercise. Although 2 out of 3 providers indicated that exercise counseling is stressed within their practice, only 14.8% of providers in the sample explicitly prescribe exercise to patients, a rate that is consistent with prior research findings.<sup>12</sup> Our results as a whole suggest that while many providers are willing to initiate discussion with at risk patients regarding the value of exercise, fewer are formalizing their recommendations via use of a written exercise prescription. A larger number of providers offer referral to professional or location, and provision of an EP was associated with use of these referrals while providers' accurate knowledge of exercise recommendations decreased the odds of referral to professional or place. While not statistically significant, provider belief that patients will engage in exercise as recommended, was also associated with increased odds of referral to place or professional. Providers with more accurate knowledge of the details of exercise recommendations might be more skeptical about patient participation in ample exercise, which might account for the decreased odds of referral associated with knowledge of recommendations. Previously identified barriers that include lack of confidence and knowledge to provide explicit patient guidelines were also reported by this physician sample.<sup>17, 18</sup>

The proportion of providers who state they provide place-based recommendations is encouraging, although what is not known is the extent to which these recommendations are of value for patients. While providers were not asked to list the range of specific places recommended, one item asked specifically whether they made referrals to exercise facilities owned by a health system. Each health system represented in this research owns or manages one or more fitness centers proximate to care facilities, and most provider referrals that were made to specific locations recommended the system-owned facility. If health system-owned fitness locations are not perceived as a convenient location by patients, provider referrals to these locations are less likely to encourage patient exercise, based on prior research that has identified lack of proximate exercise locations as a barrier to exercise in older adults.<sup>29</sup> Additionally, referrals made by physicians to community exercise locations that are geographically close to patients are associated with greater likelihood of enduring changes to exercise participation.<sup>30</sup> Therefore, providers would benefit from greater knowledge about a range of exercise resources that might be appropriate and conveniently located for patients.

To encourage non-prescribing providers to emphasize exercise, and to address lack of knowledge about places for exercise outside of system-owned facilities, these findings suggest potential interventions might be best served to focus on physician education and promotion of available information sources, especially with regard to place-based exercise resources through CCL. A CCL between a health system and community physical activity locations such as parks, community centers, and bike share programs, would offer provider access to detailed information about where to refer a patient as well as an individual to contact about the referral.<sup>31</sup> Ideally, such an agreement would include specific protocols about information sharing and patient follow up in order to track adherence to the referral by the patient and create a closed loop of communication. Operationalized clinical practices and standards of care, including CCL, could also ensure providers refer specific kinds of patients to specific kinds of locations. Development of an algorithm for exercise referrals that considers each patient's disease risk factors, socioeconomic challenges, geographic locations, and personal barriers to exercise may have potential for increasing patient adherence by considering likely patient barriers. Due to the additional mental health benefits of exercising outdoors, free access, and for some patients, proximity to their homes, patients might incur more immediate benefits, such as mood enhancement and stress reduction, and engage in exercise more frequently if referred to parks or trails. The specific characteristics of each location including free access, safety, quality, and accessibility provided by a community collaborator may increase both the number of the referrals by the provider and adherence by the patient. Additionally, outdoor spaces are often supported local and state taxes, and therefore are an economical solution when compared to the cost of accessing commercial facilities to help a greater proportion of the population to reach the national recommendations of 30 minutes of activity per day most days of the week.

Perhaps ironically, an existing model for a health system and community physical activity resource sharing plan is demonstrated by pharmaceutical industry marketing, as research has demonstrated that provider prescribing behavior is influenced by interactions with sales representatives.<sup>32</sup> Although there are clear differences between pharmaceutical prescriptions and EPs, given location knowledge gaps suggested by physician focus on referral to health system owned facilities, it is reasonable to believe that physicians might welcome exercise resource information provided by experts made available through a CCL. An added benefit of exercise location information for practitioners is that education on places for exercise might be beneficial to practitioners and clinical staff as well as patients. Future research efforts, potentially including group interviews or vignette designs, could be used to gain additional information about provider preferences for type, content, and delivery of exercise place and other EP resource information.

As with any research study, some limitations apply. The response rate from nurse practitioners, who often engage in direct patient contact, and whose view might differ from those of physicians, was extremely low (n = 8 out of 1545 email contacts). For this research, nurse practitioner alumni were contacted via last known email addresses; it is possible that these mailboxes are not currently monitored. This cross-sectional pilot study assessed a small number of practitioners who primarily represent two health systems in one region of Ohio, so results are exploratory and not generalizable. Additionally, 18.8% of total data were missing, and all data were based on self-report so actual provider practices may vary.

#### PUBLIC HEALTH IMPLICATIONS

Primary-care practitioners in the US are less likely to provide formal EPs than some of their counterparts in other developed countries. Despite the strong association of place with health, place-based referrals are not consistently provided with EPs. Data from this pilot administration of a survey suggests that Ohio physicians report barriers that prevent greater use of formal EPs or referrals to exercise professionals and specific places, including lack of exercise and place knowledge. A potential direction for intervention research is development of physician resources and information, available either via in person education or as content that can be accessed on demand via electronic health records and CCL.

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## **RESEARCH ARTICLE**

#### Age but not BMI Predicts Accelerated Progression of KOA: Data from the Osteoarthritis Initiative

Kyle D. Wallace, MPH<sup>1</sup>; Ramzi W. Nahhas, PhD<sup>2,3</sup>; Andrew W. Froehle, PhD<sup>4,5</sup>; Naila Khalil, MBBS, MPH, PhD<sup>2</sup>

<sup>1</sup>Public Health – Dayton & Montgomery County, Epidemiology Department, Dayton, OH

<sup>2</sup>Wright State University Boonshoft School of Medicine, Department of Population and Public Health Sciences, Dayton, OH

<sup>3</sup>Wright State University Boonshoft School of Medicine, Department of Psychiatry, Dayton, OH

<sup>4</sup>Wright State University College of Education and Human Services, Department of Kinesiology and Health, Dayton, OH

<sup>5</sup>Wright State University Boonshoft School of Medicine, Department of Orthopaedic Surgery, Sports Medicine and Rehabilitation, Dayton, OH

Corresponding Author: Kyle Wallace • 117 S Main St., Dayton, OH 45422 • C (937) 573-9802, W (937) 224-3691 • kwallace@phdmc.org

#### ABSTRACT

**Background/Objectives:** Knee osteoarthritis (KOA) accounts for about 35% of the arthritis burden among adults. Most adults with KOA have slowly-progressing, common knee osteoarthritis (CKOA); however, some individuals experience accelerated KOA (AKOA), rapid progression to end-stage disease within 48 months. This study analyzed individuals without radiographic evidence of KOA at baseline to determine which (baseline) characteristics were associated with progression to CKOA and/or AKOA status 48 months later.

Methods Data (n = 1,561) from the Osteoarthritis Initiative (OAI) were utilized. Multinomial logistic regression was employed to determine the magnitude of association between baseline risk factors and 48-month KOA status (AKOA and CKOA, compared to no KOA).

**Results** Older age (p = 0.032), greater baseline BMI (p < 0.001), female gender (p = 0.009), and greater baseline PASE score (p = 0.036) were significantly associated with CKOA (11.9% of participants) and/or AKOA (3.5% of participants) at 48 months. Age, BMI, and PASE were all more strongly associated with greater risk of AKOA compared to risk of CKOA (Age: OR = 1.59 vs. 0.97; BMI: OR = 1.62 vs. 1.28; PASE: OR = 1.21 vs. 1.08). Of these, only BMI was significantly associated with greater risk of both AKOA and CKOA.

**Conclusion** Certain factors impact the risk of AKOA and CKOA differently. Age did not increase the risk of CKOA, but among those with CKOA or AKOA, the proportion with AKOA increased with age. Thus, older age at onset is associated with more rapid KOA progression.

Keywords Age; osteoarthritis; accelerated knee osteoarthritis; common knee osteoarthritis

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#### INTRODUCTION

Osteoarthritis (OA) affects more than 10% of the U.S. (United States) adult population and is the third most significant cause of disability in the U.S.<sup>1</sup> Greater than 35% of adults with OA have knee osteoarthritis (KOA, including common (CKOA) and accelerated KOA (AKOA)), a quite debilitating form of OA.<sup>2</sup> Typically, CKOA is characterized by slow progression.<sup>3</sup> However, recent studies have acknowledged that about 3% to 17% of individuals with KOA rapidly progress from normal knee structure to end-stage KOA within 48 months, classified as AKOA.<sup>3</sup>

Risk factors distinguishing AKOA from CKOA are not completely understood. However, age, adiposity, and female gender may play a role. Older age is identified as a key risk factor for KOA in general.<sup>5</sup> The symptoms of KOA include pain, swelling, and stiffness, and among the elderly, KOA is the most significant cause of pain and disability.<sup>6</sup> Other symptoms such as functional impairments and reduced quality of life, concomitant with pain, are also evident.<sup>7</sup> KOA symptoms are exacerbated by obesity. Moreover, obesity can accelerate disability and reduce physical activity levels, especially in those with KOA.<sup>8</sup> Many studies have demonstrated that obesity negatively affects gait speed in individuals with KOA, as measured by the 20-meter walk test.<sup>78,9</sup> These same studies reported similar findings of limited function when measured using a standard repeated chair stand test.

The purpose of this study was to assess baseline differences among individuals being longitudinally followed for different

types of KOA (no KOA, CKOA, AKOA) regarding socio-demographic characteristics (age, ethnicity, gender, income, and education), BMI, physical performance and pain measures, and to determine which baseline characteristics predicted an individual's KOA status (no KOA, CKOA, or AKOA) 48 months later. We hypothesize that there will be a stronger association between AKOA development and older age, female gender, and elevated BMI when compared to no KOA and CKOA.

#### **METHODS**

Data for this analysis were obtained from the publicly available Osteoarthritis Initiative (OAI) database, accessible online (http:// www.oai.ucsf.edu/). From the database release version 23 the following specific datasets were used: the baseline clinical dataset (0.2.2) and the 48-month clinical dataset (6.2.2).

#### Setting:

The OAI is a multicenter prospective cohort study of older adults (ages 45 to 79 years) who had existing OA or were at risk of developing OA (n = 4,796). Four clinical sites for this study were Baltimore, Maryland; Pawtucket, Rhode Island; Pittsburgh, Pennsylvania; and Columbus, Ohio. Data collection began in 2004 and participant enrollment was completed in 2006; follow-up visits have been conducted every 12 months since. Institutional review boards at each OAI clinical site and coordinating center approved the study, and all participants provided informed consent.

#### Design:

The current study employed a prospective cohort design utilizing information from radiographic assessments of KOA to track the disease process and to determine risk factors for CKOA and AKOA. Radiographic assessment of knee degeneration was evaluated using Kellgren-Lawrence (KL) scores (grade 0 to 4) at enrollment (baseline) through 48-month follow-up. Baseline and 48-month bilateral knee radiographs with a standard fixed-flexion posterior-anterior (PA) view were taken for both knees of each participant. To assess KOA severity, two independent reviewers assigned KL scores to each knee. When scores were discrepant, an established adjudication process was employed.<sup>10</sup>

#### Participants:

At baseline of the OAI, 4,796 adults aged 45 to 79 years were enrolled. Our study excluded individuals who had radiographic evidence of KOA at baseline. Included in our study were data from individuals (n = 1,561) free of radiographic KOA (KL < 2) at baseline. These participants were categorized into three disease progression groups based on KL score at 48-month follow-up:

1) No KOA: no change in KL score in either knee

**2) CKOA:** KL score increase in at least one knee from zero to one (0 to 1) or one to two (1 to 2)

**3)** AKOA: at least one knee progressed to end-stage KOA; KL grade three (3) or four (4)

#### Measures/Outcomes:

All study related data were obtained from patient self-reports or measurements based on OAI protocol.<sup>11</sup> Demographic, medical, social, and ethnic characteristics of subjects were collected using questionnaires. Baseline age was recorded at the initial screening. Gender was reported as male or female at the initial visit. Race was dichotomized as 'White' or 'All Others' (non-White individuals grouped together due to a small number of individuals in any single other racial group). Education was classified as high school or further education versus less than high school. Annual household income was categorized as \$50,000 or more versus less than \$50,000.

Physical activity levels of study participants were evaluated using the Physical Activity Scale for the Elderly (PASE), a questionnaire assessing leisure-time, household, and occupational activities over the last seven days (scored from 0 to 400 or more; a greater score indicates more physical activity).<sup>12</sup> Participants' self-reported pain was assessed using the Western Ontario and McMaster University OA Index for pain (WOMAC), a five-point Likert scale inquiring about knee pain in the last seven days. The pain measure was the sum of five questions, each scored from zero to four [0 to 4] for a total score of zero to twenty [0 to 20], where a greater score indicates more pain, and was a mean score from the right and left knees.<sup>13</sup>

Measurements included BMI, calculated as weight in kilograms divided by the square of height in meters (kg/m2). We analyzed two different physical activity performance measures: 20-meter walk test and repeated chair stand test. The 20-meter walk test was the average speed (m/sec) at which an individual walked a distance of 20 meters. The repeated chair stand test assessed the ability to stand from a seated position without any aid; measured in the number of stands/sec over a 30-second period.

#### Statistical Analysis:

Analyses were performed using Statistical Package for the Social Science (SPSS, Version 23.0) and R version 3.3.1.<sup>14</sup> The significance cutoff for hypothesis tests was  $\alpha$  = 0.05 (two-tailed). The baseline characteristics of study participants by their KOA status at 48 months were compared. Measures of centrality and dispersion included mean and standard deviation for normally distrib-

uted continuous variables and median and interquartile range for non-normally distributed continuous variables. Categorical variables were examined via frequency distributions. For continuous variables, baseline differences between groups (no KOA, CKOA, and AKOA) were tested using Analysis of Variance (ANOVA). When groups had very serious non-normality or very different group variances (determined by Levene's Test for Equality of Variances), the Kruskal-Wallis test (non-parametric alternative to ANOVA) was used. Baseline differences between groups for categorical variables were tested using the chi-square (X<sup>2</sup>) test.

Multinomial logistic regression (R software package nnet)<sup>15</sup> was used to determine the magnitude of association between baseline risk factors and 48-month KOA status (AKOA and CKOA, compared to no KOA). Each continuous variable was divided by a factor to make odds ratios (OR) more interpretable. Reported ORs correspond to a 10-year difference in age, a five kg/m<sup>2</sup> difference in BMI, a 50-unit difference in PASE, a 0.25 m/sec difference in 20-meter walk test, 0.25 stands/sec difference in repeated chair stand test, and a 4-unit difference in WOMAC scores. These selected factors did not alter significance of statistical tests and were chosen as values that represent meaningful differences in risk factors.

All risk factors were included in the regression model simultaneously, and missing data was handled using multiple imputation (MI) via the aregImpute function in the Hmisc package in R.<sup>16-21</sup> MI assumes that missing values of a variable can be predicted from the observed values of that variable and the other risk factors.

#### RESULTS

#### Baseline Differences in Risk Factors:

The baseline characteristics of study participants by 48-month KOA status are presented in Table 1. At 48 months, 11.9% and 3.5% of the sample had developed CKOA and AKOA, respectively. Significant group differences were observed in mean age (p = 0.032), BMI (p = 0.001), and WOMAC pain score (p = 0.034). On average, individuals (at 48 months) with AKOA compared to those with CKOA and no KOA were (at baseline) older (63 years vs. 56 years and 58 years, respectively), had a higher BMI (28.89 vs. 27.92 and 27.04, respectively), and reported more pain (1.50 vs. 1.00 and 0.50, respectively). Across increasing severity of 48-month KOA status, an upward trend in BMI was observed. A similar trend was observed in WOMAC pain score; increasing KOA severity was associated with greater pain.

## Associations between Baseline Risk Factors and 48-month KOA Status:

Multivariate multinomial logistic regression results are presented in Table 2 and as a forest plot in Figure 1. Age was significantly associated with overall KOA status (p = 0.032) (Table 2). However, older age was associated with a significantly greater risk of AKOA only (OR = 1.59, p = 0.010; OR near 1 for CKOA vs. no KOA). Also, a significant association between gender and KOA status was observed (p = 0.009). Being male was protective against CKOA (OR = 0.62, p = 0.005) compared to no KOA; although the OR for males was similar for AKOA (OR = 0.69, p = 0.218), the ratio was not significant, possibly due to the smaller sample size of this group. Baseline BMI was significantly associated with 48-month KOA status overall (p < 0.001). Higher BMI was associated with a greater risk of CKOA and AKOA compared to no KOA; however, the magnitude of association was stronger for AKOA (OR = 1.62, p = 0.002) compared to CKOA (OR = 1.28, p = 0.006). PASE score was significantly associated with KOA status overall (p = 0.036); however, higher PASE score was associated with a significantly greater risk of AKOA only (OR = 1.21, p = 0.029) (OR near 1 for CKOA vs. no KOA). Figure 1 forest plot illustrates the point estimates of the ORs (and 95% confidence intervals) for CKOA and AKOA as compared to no KOA for each predictor.

Table 1. Results from	m Multivaria	able Multinomial I	_ogistic F	Regression	
Baseline Predictor	Overall p-valueª	KOA Status at 48 Months	OR	(95% CI)	p-value <sup>b</sup>
Age	0.032	No KOAc CKOA AKOA	1.00 0.97 1.59	_ (0.79-1.18) (1.11-2.25)	— 0.741 0.010
Male vs. Female	0.009	No KOAc CKOA AKOA	1.00 0.62 0.69	_ (0.44-0.86) (0.38-1.25)	 0.005 0.218
Non-White vs. White	0.779	No KOAc CKOA AKOA	1.00 1.16 0.88	_ (0.73-1.82) (0.38-2.06)	— 0.533 0.776
≥ High School vs. < High School	0.814	No KOAc CKOA AKOA	1.00 1.15 1.12	_ (0.69-1.90) (0.47-2.66)	— 0.588 0.792
< \$50K vs. ≥ \$50K	0.179	No KOAc CKOA AKOA	1.00 0.73 1.27	_ (0.49-1.08) (0.67-2.43)	— 0.117 0.461
BMI	< 0.001	No KOAc CKOA AKOA	1.00 1.28 1.62	_ (1.07-1.53) (1.19-2.22)	_ 0.006 0.002
PASE	0.036	No KOAc CKOA AKOA	1.00 1.08 1.21	_ (0.98-1.19) (1.02-1.45)	— 0.115 0.029
20m test	0.657	No KOAc CKOA AKOA	1.00 1.07 1.15	_ (0.87-1.33) (0.78-1.70)	— 0.524 0.486
Chair stand test	0.824	No KOAc CKOA AKOA	1.00 1.04 0.85	_ (0.77-1.39) (0.46-1.54)	— 0.807 0.573
WOMAC pain	0.298	No KOAc CKOA AKOA	1.00 1.18 1.38	_ (0.87-1.61) (0.84-2.28)	 0.289 0.206

Figure 1. Results from Multivariable Multinomial Logistic Regression Side-by-Side Results and Forest Plot from Multivariable Multinomial Logistic Regression

	1					
Baseline Predictor		Overall p-valueª	OR	(95% CI)	p-value <sup>b</sup>	
Age	СКОА АКОА	0.032	0.97 1.59	(0.79-1.18) (1.11-2.25)	0.741 0.010	
Male vs. Female	СКОА АКОА	0.009	0.62 0.69	(0.44-0.86) (0.38-1.25)	0.005 0.218	
Non-White vs. White	СКОА АКОА	0.779	1.16 0.88	(0.73-1.82) (0.38-2.06)	0.533 0.776	
≥ HS vs. < HS	СКОА АКОА	0.814	1.15 1.12	(0.69-1.90) (0.47-2.66)	0.588 0.792	
< \$50K vs. ≥ \$50K	СКОА АКОА	0.179	0.73 1.27	(0.49-1.08) (0.67-2.43)	0.117 0.461	
ВМІ	СКОА АКОА	< 0.001	1.28 1.62	(1.07-1.53) (1.19-2.22)	0.006 0.002	
PASE	СКОА АКОА	0.036	1.08 1.21	(0.98-1.19) (1.02-1.45)	0.115 0.029	
20m test	СКОА АКОА	0.657	1.07 1.15	(0.87-1.33) (0.78-1.70)	0.524 0.486	
Chair stand test	СКОА АКОА	0.824	1.04 0.85	(0.77-1.39) (0.46-1.54)	0.807 0.573	
WOMAC pain	СКОА АКОА	0.298	1.18 1.38	(0.87-1.61) (0.84-2.28)	0.289 0.206	
						0 0.5 1.0 1.5 2.0 2

OR ± (95% CI)

Note: ORs for continuous predictors compare odds (risk) of CKOA or AKOA vs. no KOA for a 10-year difference in age, a 5 kg/m2 difference in BMI, a 50-unit difference in PASE, a 0.25 m/s difference in the 20m walk test, a 0.25 stands/s difference in the chair stand test, and a 4-unit difference in WOMAC pain scores.

<sup>a</sup> Overall p-value for predictor.

<sup>b</sup> p-value of OR for each individual KOA status group vs. reference group.

 $^{\rm c}$  No KOA was treated as the reference group in determining CKOA and AKOA ORs.



Figure 2 displays the estimated proportions of individuals at each 48-month KOA status vs. baseline age (panel A) and baseline BMI (panel B), holding all other baseline variables fixed at their observed mean values. The figure panels A and B, show that older age and BMI at onset are associated with more rapid AKOA progression.

#### DISCUSSION

This analysis revealed that, at baseline, individuals who developed AKOA 48 months later tended to be older, and had higher BMI compared to those who developed CKOA and no KOA. At baseline, individuals who developed AKOA 48 months later reported higher levels of pain than those who developed CKOA. These differences in pain that occur before evidence of disease progression may be due to cartilage damage, bone marrow lesions, and/or meniscal pathology - knee abnormalities that are often present within individuals who later develop AKOA.<sup>4</sup> These results are similar to existing research assessing the differences in KOA symptoms by KOA severity.<sup>4,22</sup> Our results also suggest that KOA is associated with gender; and that being male was protective against CKOA and AKOA (though not significantly so for the smaller AKOA group). KOA prevalence is higher among women compared to men; it is thought that low estrogen levels among postmenopausal women increase the risk of KOA.23 Since our cohort of study participants is older (mean age 56, 63 in CKOA, AKOA, respectively), the majority of women are likely post-menopausal, and thus at greater risk of KOA.

Results from our analysis suggest that, prospectively, older age is associated with a greater risk of AKOA, even after controlling for covariates. Age is a known risk factor for KOA, but evidence has shown that individuals who develop AKOA are older than those with CKOA and no KOA.<sup>5</sup> Our results also depict a trend in baseline BMI that increases with severity of KOA at 48 months. According to our results, individuals with an elevated BMI were at an increased risk of CKOA and AKOA development; however, BMI was a stronger risk factor for AKOA (OR = 1.62) than it was for CKOA (OR = 1.28) showing a dose-response association.

In terms of absolute risk however, age of KOA onset appears to be critical in predicting disease progression. With older baseline age, the proportion of people with AKOA at 48 months demonstrated an upward trend, with a concomitant decrease in the proportions of people with CKOA or no KOA. Since participants were free of KOA at baseline, this suggests that an older age at onset is associated with an increased likelihood of rapid disease



progression toward end-stage KOA. In contrast, younger age at onset appears to be associated with slower disease progression, at least over the course of 48 months.

The pattern of absolute KOA risk for increasing BMI was different from that of age. In general, and unsurprisingly, at higher values of baseline BMI a greater proportion of the sample had some form of KOA. In terms of disease progression, however, the upward trends for CKOA and AKOA with higher baseline BMI were similar. For both CKOA and AKOA, the proportion of the sample with either disease type at 48 months increased by roughly 10% between the low and high ends of the sample's BMI range (from ~20 to 45 kg/m2). This suggests that relative to normal BMI, being extremely overweight does not increase the proportion of people with AKOA anymore than it does the proportion of people with CKOA. This finding may indicate that while BMI is a major risk factor for development of KOA in general, it is not an important determinant of accelerated disease progression.

Our study offers insight into the public health implications of KOA, and more specifically, differentiates AKOA from CKOA. However, there are some limitations to be considered. First, we observed only a small proportion of individuals with AKOA (3.5%). Our ability to identify significant associations may be limited by this small sample size. Despite this, however, we found significant associations between AKOA and age, BMI, and PASE.

Another limitation could be recall bias associated with self-reported study measures (i.e., PASE and WOMAC scores). There may also be residual confounding even after adjusting for covariates in the multivariable model. For example, there is potential for confounding with comorbidity scores and previous joint injuries, not included, which may bias our results. Data on previous knee injuries and knee surgeries (potential sources of confounding) are available in the OAI database but were not incorporated in our study for the sake of simplicity. One finding from our study differing from the literature is the association between higher PASE score (indicating more physical activity) and greater risk of AKOA (OR = 1.21). Regular physical activity is a known protective factor for several chronic diseases including KOA.9 We found it to be anomalous that a higher PASE score was a risk factor for AKOA compared to no KOA. A potential explanation is that the observed greater risk of AKOA associated with greater physical activity is limited to those with higher BMI, however a post-hoc test of the BMI x PASE interaction was not significant with ORs near 1. Aside from this counterintuitive result, our findings agree with the literature and provide further insight into the different risk factor implications of AKOA versus CKOA.

#### PUBLIC HEALTH IMPLICATIONS

KOA is a debilitating disease, common among the older population and known to reduce quality of life, thus an important public health and clinical concern. These implications not only apply to individuals with KOA but those with other forms of OA and arthritis as well. In Ohio, an estimated 30.5% (approximately 2.7 million Ohioans) of adults have been diagnosed with some form of arthritis.<sup>25</sup> The estimated percentage of adults ages 65 years and older reporting a diagnosis of some form of arthritis is nearly 57% (approximately 1.1 million elderly Ohioans).<sup>25</sup> KOA is one of the most common forms of arthritis, and even though these estimates include other types of arthritis, the burden of KOA still likely affects a considerable proportion of the adult and more specifically the older adult population in Ohio. Thus, the findings from our study are relevant to public health in Ohio and should be considered by practitioners. In general, KOA deserves significant research attention and AKOA even more so due to its aggressive nature. Among individuals at risk of KOA, especially the elderly, maintaining a normal BMI will preserve a higher quality of life and protect against AKOA.

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## **RESEARCH BRIEF**

#### Summer Employment and Tobacco Use among College Students

Rachel Hardin, BS<sup>1</sup> and Megan E. Roberts, PhD<sup>1</sup>

<sup>1</sup>The Ohio State University College of Public Health, Columbus, OH

Corresponding Author: Megan E. Roberts, PhD • 1841 Neil Avenue, Columbus, OH 43210 • 614-292-4647 • Roberts.1558@osu.edu

#### ABSTRACT

**Background:** Research has shown that tobacco use among college students is influenced by the social environment, especially among a subset of smokers known as social smokers. Although many college campuses now have tobacco-free policies that could restrict social use of tobacco products, these policies often do not extend to common places of summer employment for college students that have similar social environments. Currently, no recommended tobacco policy exists for such summer programs, and little research has been done to assess their need.

**Methods:** The objective of this study was to examine trends in tobacco use among the college-aged summer employees of a non-profit organization. Participants included the college-aged summer employees of a seasonal non-profit organization based in the Appalachian region from May through August 2015. At the beginning and end of the summer employment period, an online cross-sectional survey was distributed to each eligible staff member to examine trends in tobacco use.

**Results:** Among the 60 follow-up respondents, 22.8% (n=13) reported an overall increase in tobacco use over the summer, while 3.5% (n=2) reported a decrease in tobacco use and 73.7% (n=42) reported no change.

**Conclusions:** These results indicate that college students are at risk of increasing their tobacco use during summer employment. There is a need for further research into the role of summer workplace influences on tobacco use among college students.

Key words: tobacco, college students, social smoking, summer employment

(doi number goes here)

#### INTRODUCTION

Over the past decade, "social smoking" has been identified as a phenomenon among young smokers, especially those in college. Definitions of social smoking vary and include "those who smoke almost exclusively in social situations" <sup>1</sup> and "those who most commonly smoke while partying or socializing".<sup>2</sup> Using the latter definition, a study of college smokers at a large Midwestern university found that 70% of current smokers in the sample reported social smoking. Additionally, many of the respondents did not self-identify as smokers, despite having recently smoked.<sup>2</sup> Similarly, in a study of eight U.S. colleges, 56.3% of students who reported past 30 day use of cigarettes did not identify as smokers.<sup>3</sup> Social comparison theory suggests such young adults may think of themselves as "social smokers" as a means of mentally distancing themselves from the negative images commonly associated with smokers.<sup>4</sup>

Although social smoking research among young adults is fairly new, tobacco industry marketing documents have discussed this phenomenon for over 30 years.<sup>5</sup> The tobacco industry estimates that social smokers account for 20-25% of all smokers across a wide range of ages, socioeconomic backgrounds, levels of education, and ethnicities, yet much of their marketing efforts target young adults.<sup>5</sup> The industry documents identify young adults aged 18-24 who are undergoing a transition period, such as entering a new workplace or school setting, as a group highly susceptible to changes in tobacco consumption and target their marketing efforts accordingly.<sup>6</sup>

Social smoking poses two main concerns. First, nondaily social smokers are at risk of transitioning into daily smokers. Although the majority of social smokers do not believe they will continue smoking outside of the college environment,<sup>7</sup> studies have found otherwise. A 2005 study that traced smoking behavior

in a cohort of non-frequent college smokers found that after 4 years, 44% had quit smoking, 35% were still smoking on occasion, and 20% had transitioned to daily smoking.<sup>8</sup> Second, even low levels of cigarette smoking are a cause for concern.<sup>9</sup> Studies have shown that nondaily smoking increases the risk of disease, especially cardiovascular disease and lung cancer.<sup>10</sup>

In 2009, the American College Health Association officially recommended that all colleges and universities strive for a 100% tobacco-free environment.<sup>11</sup> As of 2015, at least 1,130 American college campuses had 100% tobacco-free policies in place.<sup>12</sup> These tobacco-free policies, however, often do not extend to common places of summer employment for college students. Each year, the youth labor force peaks during the months of April to July, especially for seasonal industries like recreational and summer camps.<sup>13,14</sup> The American Camp Association reports that 76% of camp staff are between the ages of 18 and 25, an age range that aligns closely with the age of most college students.<sup>15</sup> Although these summer programs usually do not take place on college campuses, they may create a similar social environment in which employees of similar ages work and live together.

While existing research outlines social trends in tobacco use among college students, little research has focused on tobacco use during summer employment. Like in college, the environment of summer programs may encourage social smoking and the social use of other tobacco products. This may be especially likely in areas of the country where tobacco use common. Appalachian Ohio, for example, has marked rates of cigarette use.<sup>16</sup> Furthermore, the tobacco policies of these summer programs and camps vary widely, and no recommended tobacco policy exists. As such, the objective of this study was to examine trends in tobacco use among college-aged summer employees based in Appalachia in an effort to guide future policies for similar summer programs.

#### METHODS

#### Setting:

The study population consisted of the college-aged summer staff of a non-profit organization based in Appalachia during the summer of 2015. During the initial training period and the post-summer wrap-up period, all staff were housed in the same facility. For the remainder of the summer, staff were assigned to 30 different facilities throughout 5 states.

#### Design:

Pre-summer and post-summer questionnaires were developed through Qualtrics software. The two questionnaires were identical, except for 3 follow-up questions only included on the post-summer questionnaire. As these questionnaires did not collect identifying information, pre-summer and post-summer responses were not individually linked. Instead, the two questionnaires were independent cross-sectional surveys.

#### Participants:

Staff were identified from a list provided by the organization, which included the names and email addresses of 135 staff. Nine of these individuals were year-round employees and were excluded from this study. Two other individuals refused employment prior to the start of the summer and were also excluded. The remaining 124 summer staff were contacted via email by a study investigator.

#### Procedures:

Each eligible summer staff member received a total of 4 emails from a study investigator. During May 2015, a recruitment email was sent that briefly described the study and included a link to the online questionnaire. A reminder email was sent several weeks later. During August 2015, the link to a similar post-summer questionnaire was again sent, along with a final reminder email several weeks later. The study methods and questionnaires were approved by the Institutional Review Board at The Ohio State University.

#### Measures/outcomes:

The questionnaires assessed basic demographics, including age, race, sex, highest level of education to date, college major, and position within the organization (e.g., first year staff, center director). Tobacco-use items were based on well-validated items commonly used in the field.<sup>17-18</sup> Ever-use of cigarettes, e-cigarettes, cigars/cigarillos, hookah, and smokeless tobacco (SLT) were each assessed with an item asking about using even one or two times (e.g., "Have you ever tried cigarette smoking, even one or two puffs?"). Participants were also asked about age at first cigarette. Only those reporting smoking at least 100 cigarettes were asked about current use, defined as smoking every day or some days. For the remaining tobacco products, only those reporting ever-use of a product were asked about current use. Two questions assessed participants' perceptions of their own smoking behavior ("Do you consider yourself a smoker?" "People who smoke more commonly in social situations are sometimes referred to as social smokers. Do you consider yourself a social smoker?"). In the post-summer questionnaire, participants were asked "In general, how did your level of tobacco use change this summer?" (Increased, Decreased, or Stayed the same).

#### Statistical analysis:

STATA was used to calculate descriptive statistics. Frequency distributions were performed separately for each pre-summer and post-summer variable.

#### RESULTS

A total of 63 participants responded to the pre-summer questionnaire, yielding a response rate of 50.8%. In the post-summer survey, there were 60 responses for a response rate of 48.4%. For both questionnaires, the age of respondents ranged from 18 to 26, and the average age of the sample was 20.5 (Table 1). Both samples were also primarily female (63.5%, 68.9%) and white (96.8%, 95.1%), which is representative of the broader population of employees at this organization.

At baseline, 46.8% of respondents reported ever-use of cigarettes, 14.5% reported ever-use of e-cigarettes, 40.3% reported ever-use of cigars or cigarillos, 37.1% reported ever-use of hookah, and 16.1% reported ever-use of SLT. In the post-summer questionnaire, 48.3% were ever-users of cigarettes, 18.6% were ever-users of e-cigarettes, 52.5% were ever-users of cigars or cigarillos, 39.0% were ever-users of hookah, and 13.6% were ever-users of SLT. Current use of tobacco was low in this sample, ranging from 0% for e-cigarettes to 4.8% for cigars or cigarillos at pre-summer, and 1.7% for e-cigarettes and 16.7% for cigars or cigarillos at post-summer. The average age at first cigarette was 18.1 at pre-summer and 18.6 at post-summer.

In the post-summer survey, 22.8% of respondents reported an overall increase in tobacco use over the summer, whereas 3.5% reported a decrease in tobacco use and 73.7% reported no change. Additionally, of the 9 respondents who reported smoking a cigarette in the past 6 months at baseline, 0% self-identified as a smoker. However, 69.2% of these individuals identified as social smokers under the definition "smoking more commonly in social situations."

Table 1: Demographics of Young Adult Workers, 2015							
	Pre-Summer,	Post-Summer,					
	Mean (SD)	Mean (SD)					
	or n (%)	or n (%)					
Respondents, N (Response Rate)	63 (50.8%)	60 (48.4%)					
Age	20.5 (1.6)	20.5 (1.5)					
Sex							
Male	23 (36.5%)	19 (31.2%)					
Female	40 (63.5%)	42 (68.9%)					
Race							
White/Caucasian	61 (96.8%)	58 (95.1%)					
Mixed Race/Multiple Categories	1 (1.6%)	2 (3.3%)					
Other	1 (1.6%)	1 (1.6%)					
Hispanic							
Yes	1 (1.6%)	2 (3.3%)					
No	62 (98.4%)	59 (96.7%)					
Position							
First Year	30 (48.4%)	31 (51.7%)					
Returner	15 (24.2%)	11 (18.3%)					
Center Director	13 (21.0%)	14 (23.3%)					
Support Staff	4 (6.5%)	4 (6.7%)					
Educational Status							
Rising freshman or sophomore in college	13 (21.0%)	13 (21.7%)					
Rising junior in college	20 (32.3%)	19 (31.7%)					
Rising senior in college	18 (29.0%)	19 (31.7%)					
College graduate	9 (14.5%)	8 (13.3%)					
Other	2 (3.2%)	1 (1.7%)					
College GPA							
>3.5	31 (51.7%)	37 (61.7%)					
3.0-3.5	19 (31.7%)	16 (26.7%)					
<3.0	10 (16.7%)	7 (11.7%)					
Annual Household Income							
<\$70,000	11 (22.4%)	12 (26.1%)					
\$70,000 to \$99,999	8 (16.3%)	6 (13.0%)					
\$100,000 to \$149,999	16 (32.7%)	14 (30.4%)					
\$150,000 or more	11 (22.4%)	12 (26.1%)					
Prefer not to respond	3 (6.1%)	2 (4.3%)					

#### DISCUSSION

While numerous studies have examined the role of social smoking among college students, this study extends the research by looking at college-aged youth in a summer employment setting. Findings indicated that 22.8% of our follow-up sample reported that they increased their tobacco use during their summer employment. In terms of ever-use, the most common tobacco products were cigarettes and cigars, followed by hookah, e-cigarettes, and SLT. In terms of smoker identification, while none of the participants self-identified as a smoker, about 70% of recent smokers identified as social smokers.

Compared to previous studies that assessed tobacco use among college students, a higher percentage of respondents in the present sample reported ever-use of cigarettes, while a smaller percentage reported current use.<sup>19</sup> The prevalence estimates for ever and current use of cigars and cigarillos were much higher in the sample than in other studies, while percentages were lower than expected for e-cigarette and SLT use.<sup>9.20</sup> Although cigars are traditionally viewed as a product used primarily by older men,<sup>8</sup> cigar or cigarillo use was the second highest category for ever-use in the pre-summer survey and the most common in the post-summer survey. These results align with several other studies that note the growing popularity of cigars and cigarillos among young adults.<sup>9,21</sup>

This study also contributes to the existing literature on social smoking, with the remarkable contrast between those who identify as "smokers" vs. "social smokers." Our results are consistent with findings of other studies<sup>2,3</sup> and have important implications for future interventions targeted towards young adults. For example, many basic tobacco screening questions asked by healthcare providers do not include a category for nondaily social smokers who do not classify themselves as traditional "smokers." As a result, this subgroup may miss the opportunity to receive cessation counseling or interventions. Given the prevalence of alternative tobacco use, especially cigars and cigarillos, among the sample, the term "social smoking" itself may be too narrow. Social influences on tobacco consumption appear to not be limited to cigarettes alone and instead could also affect the use of products such as e-cigarettes, cigars, cigarillos, hookah, and SLT.

Another finding of importance is the average age at first cigarette among the study sample, which was 18 for both the preand post-summer questionnaires. Data from the Adult Tobacco Survey from 2003 to 2007 found that the average age at first cigarette ranged from 14.8 to 16.<sup>4,22</sup> which is much lower than the age of initiation in the present sample. Furthermore, 77.8% of ever-cigarette users in the sample reported an age at first cigarette between the ages of 18 and 22, an age range that encompasses the majority of college students. These findings corroborate the idea that young adults, particularly those undergoing a transition in school or work, are susceptible to changes in tobacco consumption—a concept that often guides marketing strategies of tobacco companies.<sup>5,6</sup> Summer programs and industries that hire young adults should consider implementing and evaluating tobacco-free policies similar to those used on college campuses, in order to protect the health of their employees.

The primary limitation of this study lies in its cross-sectional study design. Individual participants were not traced from the beginning of employment to the end of employment, so we were unable to specifically assess how each respondent's tobacco use changed. To remedy this, a longitudinal study would be helpful in clarifying the results. The participants of this study were the summer employees of one specific organization, so the ability to generalize the results of this study is limited. Additional studies conducted in other summer employment settings with more diverse study populations are needed to fully understand the role of summer employment in tobacco use patterns among college students.

#### PUBLIC HEALTH IMPLICATIONS

This study was among the first to look at changes in young adult tobacco use during summer employment. Results aligned with previous studies of tobacco use among college students, especially in terms of the increased prevalence of cigar use and social smoker self-identification. Among our novel findings, we observed that over 1 in 5 individuals in the post-summer sample reported an increase in overall tobacco use during their summer employment.

Findings are of critical relevance to the public health of Ohio, where the adult smoking rate of 22.5% is well above the national average of 15.5%.<sup>23-24</sup> Prevalence is even higher among Ohio's college-aged students, at around 24%.<sup>25</sup> As more than 600,000 students are enrolled in higher-education in Ohio,<sup>26</sup> much more research is needed to better understand the role of summer employment on college students' tobacco use. Overall, evidence-based tobacco prevention and cessation efforts, including regulatory policies, should be targeted towards this unique and susceptible population.

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