



Impact of Targeted Local Interventions on Tuberculosis Awareness and Screening Among Persons Experiencing Homelessness During a Large Tuberculosis Outbreak in Atlanta, Georgia, 2015-2016

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Abstract

Objectives: Tuberculosis (TB) outbreaks disproportionately affect persons experiencing homelessness (PEH) in the United States. During 2014-2016, a resurgent TB outbreak occurred among PEH in Atlanta, Georgia. To control the outbreak, citywide policies and educational interventions were implemented in January 2015. Policy changes standardized and enforced TB screening requirements for PEH in homeless shelters. Educational campaigns informed PEH of the outbreak and encouraged TB screening. We evaluated factors associated with, and the effect policy changes and educational interventions had on, TB screening and awareness among PEH in Atlanta.

Methods: Questions related to TB screening and awareness of the outbreak were added to an annual US Department of Housing and Urban Development survey of PEH in Atlanta in 2015 (n = 296 respondents) and 2016 (n = 1325 respondents). We analyzed the 2016 survey data to determine characteristics associated with outcomes.

Results: From 2015 to 2016, reported TB screening increased from 81% to 86%, and awareness of the TB outbreak increased from 68% to 75%. In 2016, sheltered PEH were significantly more likely than unsheltered PEH to report being evaluated for TB in the previous 6 months (prevalence odds ratio [pOR] = 3.18; 95% confidence interval [CI], 2.28-4.47) and to report being aware of the TB outbreak (pOR = 4.00; 95% CI, 2.89-5.55).

Conclusions: Implementation of required TB screening and educational interventions may reduce the incidence and severity of TB outbreaks among PEH in other communities. Furthermore, the annual survey of PEH offers an opportunity to collect data to better inform practices and policies.

Keywords

tuberculosis, homelessness, screening policies, educational interventions, infection control, homeless shelters

Tuberculosis (TB) is an infectious disease that is 1 of the top 10 causes of mortality worldwide.¹ Although relatively rare in the United States among the general population, TB is found disproportionately in vulnerable populations, including persons experiencing homelessness (PEH).²⁻⁴ Compared with the general US population, PEH in the United States have a 10-fold increased risk of TB disease and are more often hospitalized because of the disease.³ Alcohol and drug abuse, incarceration, and HIV/AIDS—conditions that more frequently affect PEH than the general US population—are commonly reported risk factors for TB in countries with a low incidence of TB.⁵⁻¹² PEH are also more likely to have poor TB treatment

outcomes and a higher mortality rate than the general US population.^{13,14}

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PEH are particularly vulnerable to TB infection because of malnutrition and poor access to health care.^{2,4,15,16} PEH also experience overcrowded and poorly ventilated shelters, and PEH with TB are often involved in large TB outbreaks.^{3,13,17} TB outbreaks, once they begin, are particularly difficult to control among PEH because of the transient nature of the population; therefore, regular screening is necessary to identify and treat patients to reduce the chances of an isolated case turning into an outbreak.

Implementing and enforcing consistent TB screening policies for PEH should be central in the infection control practices of facilities serving PEH, especially overnight shelter facilities. Focusing resources on the identification and treatment of TB disease and latent TB infection among PEH leads to improved patient outcomes, reduced burden of disease, and cost savings to health systems.^{4,6-8,15,18,19} Furthermore, simple educational campaigns can help in reducing the spread of TB in facilities serving PEH.^{20,21} When implemented together, these interventions represent an opportunity to reduce costs and improve the health of PEH.

Program Description

In early 2014, a resurgent TB outbreak was detected in Atlanta, Georgia, which eventually grew to infect more than 50 persons.²¹⁻²³ Cases of TB occurred among residents and volunteers of 4 overnight shelters for PEH in downtown Atlanta. The Fulton County Board of Health and Mercy Care, a local federally qualified health center, formed the

Metro Atlanta TB Task Force in June 2014 with various stakeholders, including the Fulton County Department of Health and Wellness, the Centers for Disease Control and Prevention, Emory University, and shelter directors.^{23,24} The Task Force modeled guidelines after programs in San Francisco and Los Angeles to enforce a standardized TB screening policy for shelter residents, implement administrative controls designed to identify possible cases and reduce the spread of TB, design educational campaigns to inform PEH of the ongoing outbreak and encourage TB screening, and describe general infection control practices to be used by shelter staff members (Table 1).²⁵ The TB Task Force generated and disseminated preliminary guidelines to shelters and public health workers in November 2014; however, by December 2014, it was clear that immediate active dissemination and implementation of the guidelines had not occurred.^{23,25} In January 2015, to implement guidelines more quickly, additional educational initiatives (eg, information sessions, distributing teaching posters) were conducted by public health workers at shelters to support citywide implementation of guidelines.²³⁻²⁵ The standardized TB screening policy that was enforced required all PEH seeking to enter a shelter to undergo a TB symptom screen (**Box**) and provide documentation, within 7 days of arrival at a facility, of a negative TB test result (tuberculin skin test or interferon gamma release assay) in the past 6 months or documentation that they were actively undergoing treatment for latent TB infection.^{21,23-25} PEH with a positive TB test result were required to undergo further evaluation.

Table 1. Recommendations of the Metro Atlanta Tuberculosis Task Force for reducing the spread of tuberculosis (TB) in homeless shelters in Atlanta, Georgia, 2016^a

Actions	Recommendations
Enforce TB screening policy	<ul style="list-style-type: none"> Require all clients to maintain and present to the shelter a current (at minimum yearly) documentation of a TB evaluation each day they present to the shelter facility and undergo symptom screen at each intake for overnight stay.
Implement administrative controls	<ul style="list-style-type: none"> Appoint a health care liaison to oversee activities that prevent and control the spread of TB or other infectious diseases. Implement a cough alert policy, where shelter staff members alert the health care liaison or shelter manager when a coughing client is suspected to have TB. Enhance record keeping, including resident logs and bed logs, to aid in contact investigations. Routinely evaluate shelter staff members and volunteers for TB.
Take steps to reduce spread of infection	<ul style="list-style-type: none"> Have tissues readily available at intake area and tell persons who are coughing to cover their cough. <ul style="list-style-type: none"> If they have symptoms (eg, persistent cough, fever), give them a tissue to cover their cough. If possible, place them in a more isolated area away from the other shelter residents. Bed linens and towels should be used only by 1 person and laundered after use. Bathroom sinks should have hot water (110° to 130° F), soap, and paper towels. Paper masks and tissues should be given to guests with suspected active TB. Trash cans should be readily available for persons to throw away soiled masks, tissues, and paper towels.

^aData source: Georgia Department of Public Health.

Box. Tuberculosis symptom screening questions asked of persons experiencing homelessness upon entering homeless shelters, Atlanta, Georgia, 2016

- Do you have a cough that has lasted for 3 weeks or more?
- Have you had contact with person(s) with chronic cough recently?
- Have you lost weight without explanation during the past month?
- Have you coughed up blood in the past month?
- Have you been more tired than usual over the past month?
- Have you had fevers almost daily for more than 1 week?
- Have you sweated so much during the night that you've soaked your sheets or clothing during the past month?
- Do you have children with any of the above symptoms?

By summer 2015, the number of outbreak-associated TB cases among PEH was declining, possibly signifying that active TB case finding and educational outreach efforts were effective in reducing the burden of the outbreak.^{21,23,26,27} Typically, program success can be assessed through a decrease in the number of new disease cases after an intervention; however, other factors could have an effect on disease transmission. For example, the lower number of persons newly diagnosed with TB could coincide with a mild winter, generally leading to a reduction in overcrowding in shelters and reduced potential for disease transmission. Although programs similar to the one implemented in Atlanta exist, few have been validated, particularly in US populations.^{2,8,16,17}

The primary purpose of this evaluation was to use novel data collected during cross-sectional surveys of PEH in Atlanta to determine how the outbreak-related TB screening policy, educational campaigns, and administrative controls affected TB testing practices and TB awareness among PEH. This analysis aimed to characterize factors associated with self-reported TB evaluation and awareness of the TB outbreak. Furthermore, we sought to demonstrate that data collected in annual surveys of PEH can be used to evaluate practices and policies aimed at PEH.

Methods

Data Source and Variables

The US Department of Housing and Urban Development (HUD) established the homeless services Continuum of Care (CoC) program in 1995 to streamline funding application

processes and promote community-wide planning and strategic use of resources to address homelessness.²⁸⁻³⁰ A CoC is a regional or local planning body that coordinates housing and services funding for PEH. According to HUD, CoCs aim to organize and deliver housing and supportive services (eg, case management, mental health services, employment assistance) to meet the needs of PEH as they move to stable housing. They also take action to end homelessness and prevent a return to homelessness. In 2018, more than 400 CoCs represented cities, suburbs, and rural areas.^{28,29}

HUD requires CoCs to conduct an annual point-in-time (PIT) count: a census of PEH, sheltered and unsheltered, on a designated night in January.³⁰ Sheltered PEH are defined as persons living in a supervised, publicly or privately operated shelter designated to provide a temporary living arrangement on the night of the PIT count. Unsheltered PEH are defined as persons staying in public or private places not designed for or ordinarily used as regular sleeping accommodations (eg, under a bridge, in a tent) during the period between dusk and dawn on the night designated for the PIT count.³¹ CoC volunteers take an inventory of sheltered PEH using administrative records and in-person interviews and travel to locations across the area to identify and interview unsheltered PEH. Volunteers collect information on demographic characteristics, medical conditions, and socioeconomic characteristics. The CoCs use this information to better serve their clients.^{29,30} CoCs complete the PIT count on a designated night or during the 7 days after the night of the count (ie, post-night). PIT surveys conducted post-night determine a person's sheltered status on the designated night of the count.

Starting in 2015, the Atlanta CoC PIT survey included 2 questions related to TB screening and awareness of the current TB outbreak: (1) Have you been tested or evaluated for TB in the last 6 months? and (2) Are you aware that there is currently an outbreak of TB in the downtown Atlanta homeless population? We used these questions to understand the effect of the TB screening policy, educational outreach efforts, and administrative controls on persons' TB testing practices (question 1) and knowledge of the TB outbreak (question 2). Responses to questions were yes or no; we excluded from this analysis respondents who did not answer the questions.

The main exposure variable of interest in our analysis was whether a person resided in a homeless shelter (ie, sheltered) on the designated night of the PIT survey. For analysis purposes, we considered cohort subjects to be sheltered if they reported spending the night of the designated PIT count at an emergency shelter or domestic violence shelter and unsheltered if they reported spending the night elsewhere (eg, on the street or in a vehicle, park, abandoned building, or outdoor encampment). In addition, interviewers asked participants to self-report if they were currently experiencing or had ever experienced mental illness, HIV/AIDS, drug abuse, alcohol abuse, or any chronic medical condition.

In the 2015 PIT count, interviewers asked the TB questions only of a convenience subset of participants; thus, data from 2015 were limited. In addition, demographic data were not linked to the TB question response data in the 2015 PIT count because of data limitations. As such, only responses to the TB-related questions on 2015 PIT count, representing a subset of the entire population counted, were available for comparison with the 2016 PIT data. Most of the data for this evaluation came from the annual PIT count in Atlanta administered by the Atlanta CoC in January 2016. Unlike the 2015 PIT count, all participants were asked the TB questions, and responses were linked to participants' demographic data.

Analysis

We summarized data on demographic characteristics, homelessness, and medical conditions. In addition, we compared responses to the TB-related questions from the 2016 PIT survey with responses from the 2015 PIT survey by using the Pearson χ^2 test to compare sample proportions.

We stratified cohort participants by shelter status on the night of the 2016 PIT count, and we compared characteristics between the 2 groups (sheltered and unsheltered) by using the Pearson χ^2 test. We analyzed factors related to recent TB evaluation and knowledge of the current TB outbreak by calculating prevalence odds ratios (pORs), corresponding 95% confidence intervals (CIs), and mid-exact *P* values, with *P* < .05 considered significant. We included variables that were significantly associated with the outcome in a fully adjusted multivariate logistic model that controlled for race and health conditions. We calculated pORs and adjusted odds ratios (aORs) for all predictors in the fully adjusted models. We performed analyses by using SAS version 9.4 and OpenEpi version 3.01.^{32,33}

The Emory University Institutional Review Board (IRB) determined that the evaluation design, execution, and data analysis did not meet the definition of research with human subjects as set forth in Emory policies and procedures and federal rules; CDC officials not involved in the evaluation concluded that tasks performed by CDC coauthors did not involve human research that requires IRB approval.

Results

The Atlanta CoC interviewed 1369 PEH for the 2016 PIT count designated for the night of January 25, 2016 (Table 2). Among the participants, 741 (54.1%) reported being sheltered on the night of January 25. Of 1305 respondents to the question, 628 (48.1%) reported that this was their first time experiencing homelessness; of 1213 respondents to the question, 564 (46.5%) reported experiencing homelessness ≥ 2 times during the past 3 years. Respondents were, on average, aged 49 (interquartile range, 38-56); most respondents were black (1146 of 1343; 85.3%) and male (1153 of 1369; 84.2%). Information on current and past medical conditions was available for 1045

(76.3%) participants. Mental illness, drug abuse, alcohol abuse, physical disabilities, posttraumatic stress disorder, and other chronic medical conditions were commonly reported. When stratifying on sheltered status on the night of the 2016 PIT count, sheltered participants were more likely than unsheltered participants to be black (*P* = .002) and male (*P* = .001). Unsheltered PEH were more likely than sheltered PEH to report a history of mental illness (*P* = .01), alcohol abuse (*P* < .001), and drug abuse (*P* < .001).

The percentage of PIT respondents who were aware of the TB outbreak increased significantly from 67.9% (201 of 296; 0 missing) in the 2015 survey to 75.1% (995 of 1325; 45 missing) in the 2016 survey (*P* = .01). The percentage of PEH who reported recent TB evaluation also increased from 81.1% (240 of 296; 0 missing) in the 2015 survey to 85.9% (1145 of 1333; 37 missing) in the 2016 survey (*P* = .03).

Characteristics Associated With Recent TB Evaluation

In the 2016 survey, 185 of 1369 (13.5%) persons said they had not been evaluated for TB in the past 6 months (Table 3). Persons who were sheltered (pOR = 3.18; 95% CI, 2.28-4.47), black (pOR = 2.48; 95% CI, 1.55-3.90), or aware of the outbreak (pOR = 4.00; 95% CI, 2.86-5.56) were all more likely to have been evaluated for TB in the past 6 months than persons who were unsheltered, white, or unaware of the outbreak, respectively.

Lacking shelter and poor awareness of the TB outbreak were both separately found to be significantly associated with not having had a recent TB evaluation after controlling for race, HIV/AIDS status, drug abuse, alcohol abuse, mental illness, and chronic medical conditions. Persons who were sheltered had higher adjusted odds of a recent evaluation than persons who were unsheltered (aOR = 2.05; 95% CI, 1.36-3.09). Persons who reported being aware of the TB outbreak also had higher adjusted odds of a recent TB evaluation than persons who did not report being aware of the TB outbreak (aOR = 3.34; 95% CI, 2.32-4.82) (Table 3).

Characteristics Associated With TB Outbreak Awareness

Overall in 2016, 24.9% (330 of 1325) of respondents said they were unaware of the TB outbreak in the homeless population in Atlanta (Table 4). Sheltered persons had more than twice the odds of being aware of the TB outbreak than unsheltered persons (pOR = 2.38; 95% CI, 1.84-3.08). In addition, men (pOR = 1.85; 95% CI, 1.33-2.56) and persons with a recent TB evaluation (pOR = 4.00; 95% CI, 2.89-5.55) were more likely to be aware of the outbreak.

After controlling for race, HIV/AIDS status, drug abuse, alcohol abuse, mental illness, and chronic medical conditions, persons who were sheltered (vs unsheltered) (aOR = 1.82; 95% CI, 1.33-2.50), persons with a recent TB evaluation (vs without a recent TB evaluation) (aOR = 3.36; 95%

Table 2. Characteristics of participants in the point-in-time count and survey on tuberculosis (TB) screening and TB outbreak awareness among persons experiencing homelessness, Atlanta, Georgia, January 2016^a

Variables	Total (n = 1369)	Sheltered (n = 741)	Unsheltered (n = 628)	P Value ^b
	No. (%)	No. (%)	No. (%)	
Experience of homelessness				
Sheltered	741 (54.1)	NA	NA	
First-time homeless ^c	628 (48.1)	330 (47.5)	298 (48.9)	.62
Homeless ≥2 times in past 3 years ^d	564 (46.5)	325 (48.0)	239 (44.6)	.30
Demographic characteristics				
Age, y				
<18	2 (0.1)	2 (0.3)	0	.08
18-24	57 (4.2)	35 (4.8)	22 (3.6)	
25-34	197 (14.7)	115 (15.6)	82 (13.5)	
35-44	244 (18.2)	126 (17.1)	118 (19.4)	
45-54	453 (33.7)	229 (31.2)	224 (36.8)	
55-64	323 (24.1)	185 (25.2)	138 (22.7)	
≥65	67 (5.0)	43 (5.9)	24 (3.8)	
Total	1343 (100.0)	735 (100.0)	608 (100.0)	
Race				
Black	1146 (85.8)	645 (88.6)	501 (82.5)	.002
Other/multiracial	80 (6.0)	41 (5.6)	39 (6.4)	
White	109 (8.2)	42 (5.8)	67 (11.0)	
Total	1335 (100.0)	728 (100.0)	607 (100.0)	
Hispanic	37 (2.7)	17 (2.3)	20 (3.2)	.24
Male	1153 (84.2)	646 (87.2)	507 (80.7)	.001
Veteran	160 (11.7)	81 (10.9)	79 (12.6)	.24
Current or past medical conditions ^e				
Mental illness	233 (22.3)	79 (18.4)	154 (25.0)	.01
HIV/AIDS	31 (3.0)	10 (2.3)	21 (3.4)	.31
Drug abuse	175 (16.7)	51 (11.9)	124 (20.2)	<.001
Alcohol abuse	202 (19.3)	51 (11.9)	151 (24.6)	<.001
Chronic medical condition	238 (22.8)	95 (22.1)	143 (23.3)	.66
Total	1045 (100.0)	430 (100.0)	615 (100.0)	

Abbreviation: NA, not applicable.

^aThe point-in-time count is an annual count of all persons experiencing homelessness in a community on a single night in January of each year that is organized by community members to collect and report data for the US Department of Housing and Urban Development.

^bUsing the Pearson χ^2 test, with $P < .05$ considered significant.

^cData on first-time homeless were missing for 64 persons surveyed (46 sheltered, 18 unsheltered).

^dData on previous homelessness were missing for 156 persons surveyed (64 sheltered, 92 unsheltered).

^eRespondents could report >1 condition. As such, numbers do not add up to total.

CI, 2.32-4.84), and men (vs women) (aOR = 1.72; 95% CI, 1.16-2.54) were more likely to be aware of the TB outbreak (Table 4).

Lessons Learned

Implementation of the new TB screening policy, educational efforts, and administrative controls coincided with an increase in self-reported TB evaluations and a rise in

awareness of the TB outbreak among PEH in Atlanta. These findings, in conjunction with declining TB cases,^{21,23} could indicate that these efforts successfully targeted sheltered PEH and encouraged TB screening among this population. Although the proportion of PEH who reported recent TB evaluation and awareness of the TB outbreak increased significantly from 2015 to 2016, the overall percentage increase was modest. However, no baseline data were available on the percentage of PEH with a documented TB evaluation in

Table 3. Characteristics associated with recent tuberculosis (TB) evaluation among participants in the point-in-time count and survey on TB screening and TB outbreak awareness among persons experiencing homelessness, Atlanta, Georgia, January 2016^a

Variable	Recent TB Evaluation ^b (n = 1148)	No Recent TB Evaluation ^b (n = 185)	pOR ^c (95% CI)	P Value ^d
	No. (%)	No. (%)		
Experience of homelessness				
Sheltered	666 (57.9)	56 (30.3)	3.18 (2.28-4.47)	<.001
First-time homeless ^e	529 (48.4)	85 (47.0)	1.01 (0.74-1.38)	.72
Homeless ≥ 2 times in last 3 years ^f	468 (41.7)	78 (50.0)	0.95 (0.69-1.30)	.37
Awareness of the TB outbreak among homeless persons ^g	903 (79.2)	88 (48.9)	4.00 (2.86-5.56)	<.001
Demographic characteristics				
Age, y				
<18	2 (0.2)	0	— ^h	.79
18-24	44 (3.9)	11 (6.0)	0.62 (0.30-1.27)	.20
25-34	165 (14.7)	28 (15.3)	0.91 (0.76-1.48)	.70
35-44	215 (19.1)	22 (12.0)	1.51 (0.90-2.54)	.11
45-54	381 (33.9)	59 (32.2)	1.00 [Reference]	
55-64	263 (23.4)	51 (27.9)	0.80 (0.53-1.20)	.28
≥ 65	55 (4.9)	12 (6.6)	0.71 (0.36-1.40)	.33
Total	1125 (100.0)	183 (100.0)		
Race (n = 1313)				
Black	981 (86.9)	147 (79.9)	2.48 (1.55-3.90)	<.001
Other/multiracial	70 (6.2)	8 (4.3)	3.23 (1.42-7.99)	.34
White	78 (6.9)	29 (15.8)	1.00 [Reference]	
Total	1129 (100.0)	184 (100.0)		
Hispanic	33 (2.9)	2 (1.1)	2.71 (0.76-16.89)	.15
Male	982 (85.5)	148 (80.9)	1.48 (0.99-2.18)	.06
Veteran	128 (11.1)	27 (14.8)	0.73 (0.47-1.17)	.18
Current or past medical and social conditions ⁱ				
Mental illness	178 (20.9)	45 (27.4)	0.70 (0.48-1.03)	.07
HIV/AIDS	30 (3.5)	1 (0.6)	5.94 (1.12-12.33)	.03
Drug abuse	139 (16.3)	35 (21.3)	0.72 (0.48-1.10)	.12
Alcohol abuse	161 (18.9)	39 (23.8)	0.75 (0.50-1.12)	.15
Chronic medical condition	193 (22.6)	40 (24.4)	0.91 (0.61-1.35)	.62
Total providing medical history	853 (100.0)	164 (100.0)		
Factors associated with recent TB evaluation ^j				
	pOR (95% CI)		aOR^k (95% CI)	
Sheltered	3.18 (2.28-4.47)		2.05 (1.36-3.09)	
Awareness of the TB outbreak in the homeless	4.00 (2.86-5.56)		3.34 (2.32-4.82)	

Abbreviations: aOR, adjusted odds ratio; pOR, prevalence odds ratio.

^aThe point-in-time count is an annual count of all persons experiencing homelessness in a community on a single night in January of each year that is organized by community members to collect and report data for the US Department of Housing and Urban Development.

^bResponses to the question, "Have you been tested or evaluated for TB in the last 6 months?" were missing for 37 persons (19 sheltered, 18 unsheltered).

^cConditional maximum likelihood estimated odds ratios of having received a TB evaluation, 95% CIs, and corresponding *P* values. Unless otherwise specified, the reference group included the point-in-time survey respondents who answered no on the corresponding yes or no question.

^dUsing the Pearson χ^2 test, with *P* < .05 considered significant.

^eData on previous homelessness were missing for 59 persons surveyed (55 with a recent TB evaluation, 4 without a recent TB evaluation).

^fData on number of times previously homeless was missing for 54 persons surveyed (26 with a recent TB evaluation, 29 without a recent TB evaluation).

^gResponses to the question, "Are you aware that there is currently an outbreak of TB in the downtown Atlanta homeless population?" were missing for 13 persons in this subcohort, 8 of whom had been evaluated for TB and 5 of whom had not been evaluated for TB.

^hUndefined value.

ⁱRespondents could report >1 condition.

^jControlling for race, HIV/AIDS status, mental illness, chronic medical conditions, drug abuse, and alcohol abuse.

Table 4. Characteristics associated with being aware of a tuberculosis (TB) outbreak among participants in the point-in-time count and survey on TB screening and TB outbreak awareness among persons experiencing homelessness, Atlanta, Georgia, January 2016^a

Variable	Aware of TB Outbreak ^b (n = 995)	Unaware of TB Outbreak ^b (n = 330)	pOR ^c (95% CI)	P Value ^d
	No. (%)	No. (%)		
Experience of homelessness				
Sheltered	591 (59.4)	126 (38.2)	2.38 (1.84-3.08)	<.001
First-time homeless ^e	448 (47.4)	161 (50.0)	0.83 (0.67-1.11)	.24
Homeless \geq 2 times in last 3 years ^f	416 (47.3)	128 (44.0)	1.14 (0.88-1.47)	.32
Evaluated for TB in past 6 months ^g	904 (91.0)	236 (72.0)	4.00 (2.89-5.55)	<.001
Demographic characteristics				
Age, y				
<18	2 (0.2)	0	— ^h	.56
18-24	35 (3.6)	20 (6.2)	0.60 (0.33-1.08)	.10
25-34	142 (14.6)	48 (15.0)	1.01 (0.69-1.50)	.95
35-44	168 (17.2)	69 (21.5)	0.83 (0.59-1.19)	.32
45-54	327 (33.5)	112 (34.9)	1.00 [Reference]	
55-64	252 (25.8)	57 (17.8)	1.51 (1.06-2.17)	.02
\geq 65	51 (5.2)	15 (4.7)	1.16 (0.63-2.15)	.64
Total	975 (100.0)	321 (100.0)		
Race				
Black	851 (86.4)	267 (81.2)	1.68 (1.10-2.56)	.02
Other/multiracial	54 (5.5)	25 (7.6)	1.14 (0.61-2.14)	.68
White	70 (7.1)	37 (11.2)	1.0 [Reference]	
Total	975 (100.0)	329 (100.0)		
Hispanic	23 (2.3)	12 (3.6)	0.64 (0.31-1.30)	.22
Male	865 (86.9)	260 (78.8)	1.85 (1.33-2.56)	<.001
Veteran	111 (11.2)	45 (13.6)	0.80 (0.55-1.15)	.23
Current or past medical and social conditions ⁱ				
Mental illness	166 (22.7)	59 (21.2)	1.09 (0.78-1.53)	.61
HIV/AIDS	22 (3.0)	9 (3.2)	0.93 (0.42-2.04)	.84
Drug abuse	127 (17.4)	47 (16.9)	1.04 (0.72-1.49)	.86
Alcohol abuse	142 (19.5)	57 (20.5)	0.92 (0.66-1.32)	.71
Chronic medical condition	168 (23.0)	66 (23.7)	0.96 (0.69-1.33)	.80
Total	730 (100.0)	278 (100.0)		
Factors associated with awareness of TB outbreak ^j				
	pOR (95% CI)		aOR ^k (95% CI)	
Sheltered	2.38 (1.84-3.08)		1.82 (1.33-2.50)	
Evaluated for TB in past 6 months	4.00 (2.89-5.55)		3.36 (2.32-4.84)	
Male sex	1.85 (1.33-2.56)		1.72 (1.16-2.54)	

Abbreviations: aOR, adjusted odds ratio; pOR, prevalence odds ratio.

^aThe point-in-time count is an annual count of all persons experiencing homelessness in a community on a single night in January of each year that is organized by community members to collect and report data for the US Department of Housing and Urban Development.

^bResponses to the question, "Are you aware that there is currently an outbreak of TB in the downtown Atlanta homeless population?" were missing for 45 persons.

^cConditional maximum likelihood estimated odds ratios of being aware of the TB outbreak, 95% CIs, and corresponding P values. Unless otherwise specified in the table, the reference group for comparisons included the point-in-time survey respondents who answered no on the corresponding yes or no question.

^dUsing the Pearson χ^2 test, with $P < .05$ considered significant.

^eData on previous homelessness were missing for 58 persons surveyed (50 who were aware of the TB outbreak, 8 who were not).

^fData on number of times previously homeless were missing for 154 persons surveyed (115 who were aware of the TB outbreak, 39 who were not).

^gResponses to the question, "Have you been tested or evaluated for TB in the last 6 months?" were missing for 4 persons in this subcohort, 2 of whom were aware of the TB outbreak and 2 of whom were not aware of the TB outbreak.

^hUndefined value.

ⁱRespondents could report >1 condition.

^jControlling for race, HIV/AIDS status, mental illness, chronic medical conditions, drug abuse, and alcohol abuse.

Atlanta before implementation of the outbreak-related interventions in January 2015. Residence in a homeless shelter on the night of the PIT count was associated with recent TB evaluation and awareness of the current TB outbreak among PEH in Atlanta. Persons who were sheltered, and therefore presumably held to the TB screening policy by shelter staff members, had more than 3 times the odds of being evaluated than persons who were not sheltered. Similarly, sheltered PEH, who were presumably more likely than unsheltered PEH to be reached by the educational outreach efforts made by various stakeholders in Atlanta, were twice as likely to be aware of the TB outbreak than unsheltered PEH. Consistent with findings of similar TB programs in other cities, the mandatory TB screening policy and educational outreach efforts were followed by a decrease in the number of active TB cases among PEH in Atlanta.^{8,16,17}

Limitations

This evaluation had several limitations. First, PEH are a highly transient and dynamic population, and data were collected on a sample of persons at a single PIT in 2015 and 2016. The 2016 PIT survey in Atlanta estimated approximately 4063 PEH in Atlanta,³⁴ and interviews sampled only 1370 (33.7%) persons. Furthermore, the PIT methodology places an emphasis on persons living in homeless facilities and persons living in unsheltered locations where PEH are known to reside, therefore missing a portion of the population by design. Although the PIT is the most comprehensive data collection effort among the PEH population, we cannot say how representative our analytic cohort is, because no other data sources exist to validate the characteristics of our sample. However, this evaluation is not unique in being unable to capture a larger majority of PEH in an analytic cohort.^{8,16,17} Second, the evaluation was limited by self-report and the possibility that respondents could inaccurately report TB knowledge and testing practices. Self-reported recent TB evaluations might have been overestimated because persons staying in shelters might have been more likely than unsheltered PEH to falsely report having been recently evaluated for TB because they were aware it was a requirement for their stay in the shelter.

Finally, this analysis was not a pre-implementation vs post-implementation evaluation. Rather, it compared data collected early in implementation (2015 PIT) with data collected after the program had been implemented for 1 year (2016 PIT). Because the TB-related questions were new to the PIT count in 2015, no data on a true pre-implementation cohort were available. Because the analysis accessed changes in testing and TB awareness during a 1-year period during implementation, the results presented likely underestimated the program's impact. Furthermore, the study showed that communities can leverage the PIT count to collect data on the PEH population to evaluate programs and policies to better serve PEH.

Public Health Implications

To our knowledge, this analysis is the first of its kind in a large US city, and the results can be used to inform future program efforts. This analysis provides practical baseline data on TB knowledge and testing practices among PEH in Atlanta and can be used in conjunction with data from future PIT counts to assess trends in TB knowledge and testing practices. These findings lend support to broader implementation of administrative controls in homeless shelters to improve TB control practices.

This analysis supports the implementation of similar TB control programs across the country in urban areas that may be dealing with a TB outbreak among PEH. The findings show that a coordinated community response to a TB outbreak can be effective in reaching a large portion of the intended population. Because the program in Atlanta was modeled after programs in Los Angeles and San Francisco, other localities could adopt similar measures to address TB outbreaks among PEH.

The results of this evaluation indicate that educational efforts to inform PEH in Atlanta of the recent TB outbreak reached most persons sleeping in homeless shelters. The implementation of administrative controls and educational campaigns was shown to have positive effects on the proportion of PEH who were aware of the TB outbreak and were evaluated per TB screening policy; however, a significant portion of unsheltered PEH remained unaware of the TB outbreak. Consistent TB screening among PEH should continue to reduce the risk of future outbreaks among PEH.^{3,23} Educational efforts to inform PEH, shelter staff members, and shelter volunteers of infection control practices should continue to reduce the incidence of TB among PEH.^{7,10,27}

Implementing administrative controls in TB control efforts can lead to higher proportions of TB testing and higher TB awareness among PEH, which can help prevent and reduce the burden of TB outbreaks in this population. The results of this evaluation support the widespread implementation of administrative controls in TB control programs as a strategic way to reduce new and resurgent TB outbreaks among PEH in urban areas.

Authors' Note

The findings and conclusions in this article are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Acknowledgments

The authors acknowledge the contributions of Tom Andrews, Lindsey Barranco, Anne Spaulding, and Sapna Bamrah Morris; colleagues at the Fulton County Board of Health and Georgia Department of Public Health; members of the Atlanta TB Task Force and Atlanta Continuum of Care; and survey volunteers with the Atlanta Continuum of Care who supported completion of this work.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors received no financial support with respect to the research, authorship, and/or publication of this article.

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