Original Article

Prevalence and Characteristics of Tuberculosis in the Korean Homeless Population Based on Nationwide Tuberculosis Screening

Heesang Han, B.S.[1]*, Ji-Hee Lee, M.D.[2]*, Sung Jun Chung, M.D., Ph.D.[2], Beong Ki Kim, M.D., Ph.D.[2], Yedham Kang, B.S.[2], Hangseok Choi, Ph.D.[3], Hee-Jin Kim, M.D., M.P.H.[4] and Seung Heon Lee, M.D., Ph.D.[2]

[1]Korea University College of Medicine, Seoul, [2]Division of Pulmonary, Sleep, and Critical Care Medicine, Department of Internal Medicine, [3]Medical Science Research Center, Korea University Ansan Hospital, Ansan, [4]Central Education Institution, Korean National Tuberculosis Association, Seoul, Republic of Korea
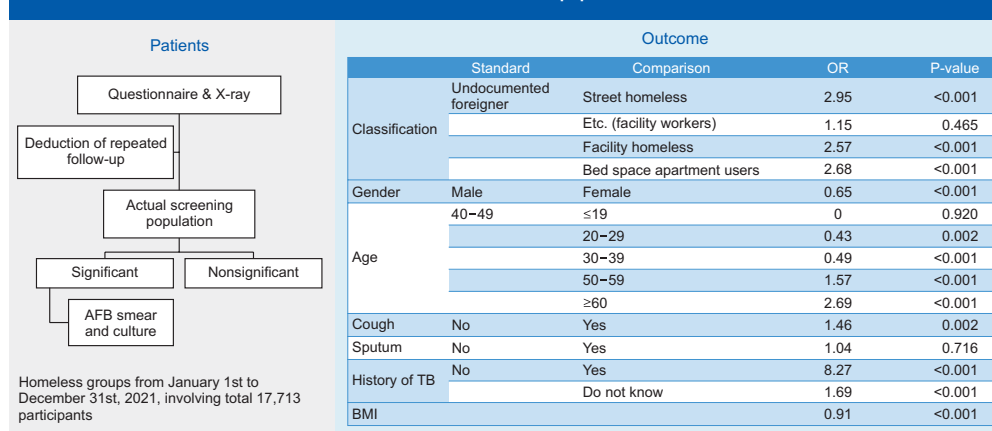
Check for updates

Address for correspondence
Seung Heon Lee, M.D., Ph.D.
Division of Pulmonary, Sleep and Critical Care Medicine, Department of Internal Medicine, Korea University Ansan Hospital, 123 Jeokgeum-ro, Danwon-gu, Ansan 15355, Republic of Korea
Phone 82-31-412-4973
Fax 82-31-412-5604
E-mail lee-sh@korea.ac.kr

*These authors contributed equally to the manuscript as first author.

Prevalence and characteristics of tuberculosis through nationwide tuberculosis screening in the Korean homeless population

Patients

Homeless groups from January 1st to December 31st, 2021, involving total 17,713 participants

Outcome

	Standard	Comparison	OR	P-value
Classification	Undocumented foreigner	Street homeless	2.95	<0.001
		Etc. (facility workers)	1.15	0.465
		Facility homeless	2.57	<0.001
		Bed space apartment users	2.68	<0.001
Gender	Male	Female	0.65	<0.001
Age	40–49	≤19	0	0.920
		20–29	0.43	0.002
		30–39	0.49	<0.001
		50–59	1.57	<0.001
		≥60	2.69	<0.001
Cough	No	Yes	1.46	0.002
Sputum	No	Yes	1.04	0.716
History of TB	No	Yes	8.27	<0.001
		Do not know	1.69	<0.001
BMI			0.91	<0.001

Conclusion
· The prevalence of TB among the homeless population is higher compared to the general population
· TB confirmation rate was higher among individuals with 'inactive TB' on chest X-ray

Abstract

Background: The government of Korea implemented a strategy of prevention and early diagnosis in high-risk groups to reduce the tuberculosis (TB) burden. This study aims to investigate the TB epidemiology and gap in understanding of TB prevalence among homeless individuals by analyzing active TB chest X-ray (CXR) screening results in Korea.

Methods: The Korean National Tuberculosis Association conducted active TB screening with CXR for homeless groups from January 1 to December 31, 2021. Sputum acid-fast bacilli smear and culture were performed for the subjects suggestive of TB on CXR. We performed a cross-sectional analysis of the data in comparison with the national health screening results from the general population.

Results: Among 17,713 homeless persons, 40 (0.23%), 3,077 (17.37%), and 79 (0.45%) were categorized as suggested TB, inactive TB, and observation required, respectively. Prevalence of suggested TB in the homeless was significantly higher (3–5 fold) than in

the national general health screening based on age category (p<0.005). Twenty-nine cases were confirmed as TB, yielding a prevalence of 164 cases per 100,000 individuals; 19 of these 29 cases showed inactive TB on CXR. Body mass index (p=0.0478) and CXR result (p<0.001) significantly correlated with confirmed TB based on multivariable analysis.

Conclusion: Nutrition status and CXR results, especially that of inactive TB, should be considered in active TB screening of the homeless population, where TB prevalence is higher than the general population.

Keywords: Homeless; Tuberculosis; Screening; Chest X-Rays; Suggested Tuberculosis

Introduction

The tuberculosis (TB) incidence in Korea was reportedly 44/100,000 in 2021[1], and high-risk groups including homeless, prisoners, and immigrants are targets of active case findings for prevention and early diagnosis in the third National Strategic Plan for TB Control[2]. The homeless population has a high TB prevalence due to poor hygiene, alcohol abuse, and drug use[3]. Therefore, many countries have established TB screening guidelines using chest X-ray (CXR), tuberculin skin test, and interferon-gamma release assay for active and latent TB in vulnerable groups based on TB burden[4].

The Homeless Persons Welfare Act in Korea defines a homeless person as an individual who lives without a fixed residence for a considerable period of time or a person who uses a homeless facility such as a side-by-side counseling center, a temporary shelter for the homeless, a homeless rehabilitation/nursing/self-support facility, or a homeless general support center[5]. The homeless population can be categorized as street homeless, facility workers, undocumented foreigners, homeless persons in facilities, and bed space apartment users. According to the 2021 Homeless Survey, the composition of the population who did not visit the hospital was 37.5% street homeless people, 3.1% homeless people in facilities, and 9.1% bed space apartment users. This indicates that access to health care services is limited in the homeless population.

The World Health Organization post-2015 End TB Strategy recommended TB screening for possible risk groups with low access to medical care including the homeless, and the integrated patient management of pillar I strategy emphasized the importance of early diagnosis in high-risk groups. In addition, any proposed screening strategy should use early diagnostic methods and allow effective treatment and follow-up to sustain case management[6]. However, reports on current TB status in the homeless are scarce, although one investigated direct observed therapy and demonstrated poor treatment adherence[7] in Korea.

Active case finding is a provider-initiated strategy to detect and treat patients with TB who would not otherwise receive prompt medical services. In contrast, passive case finding is based on patients' voluntary presentation to a health care provider[8]. An active case finding program screens a large population to identify active TB cases, usually with CXR. However, in relation to the health system context and resource availability several concerns exist regarding the accuracy of TB detection, differential diagnosis from inactive TB, consecutive prompt diagnosis and treatment, and economic and social consequences. Despite the low specificity of CXR (46% to 89%)[4], that depends on qualified web-based remote interpretation of digitalized portable instruments[9], CXRs can provide sufficient data for TB screening followed by additional diagnostics, such as a sputum acid-fast bacillus (AFB) smear and cultures.

This study reports TB epidemics of the homeless compared with the general population and investigates the factors related to suggested and confirmed TB on CXR.

Materials and Methods

1. Study design

TB screening programs for the homeless were performed by the Korean National Tuberculosis Association (KNTA) as a TB prevention and support project from January 1 to December 31, 2021. The primary goals of this cross-sectional study were early detection of active TB, prevention of cross-transmission in the community, and to refer and manage patients with TB systematically. The analysis was performed after completion of the projects with approval from the Institutional Review Board (No: 2022AS0066) of Korea Univer-

sity Ansan Hospital and permission from the KNTA and Korea Disease Control and Prevention Agency. The Institutional Review Board waived the need for consents from the participants.

2. TB screening process

Selection criteria for the homeless were as follows[5]: (1) the residence status at the time of survey was documented; (2) the homeless were classified as street homeless who live without a fixed residence and facility homeless who use a homeless facility such as a temporary shelter or support center; and (3) bed space apartment users were classified based on the location of the counseling center.

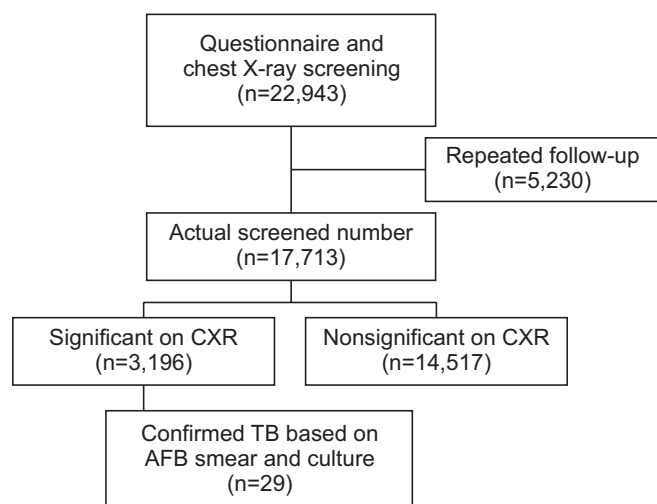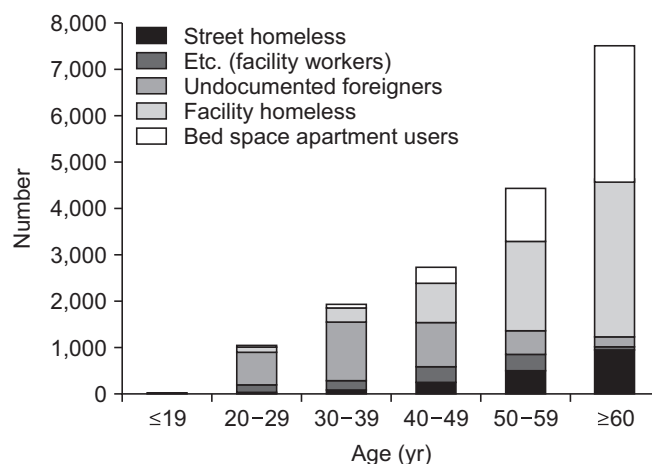The flowchart for the screening process is shown in Figure 1. A history-taking questionnaire was performed and CXRs of the homeless were interpreted by a chest radiologist using a remote online system, all directed by regional branch offices of KNTA. The patients showing significant findings of TB on CXR were categorized as: suggested TB, observation required (uncertain TB with undefined activity), or inactive TB. Patients without significant findings of TB on CXR were defined as normal or with other significant lung disease. The CXR findings based on category are summarized in Supplementary Table S1. Sputum samples were collected on site for groups with significant findings of TB on CXR for further AFB smears and cultures. Vehicles equipped with CXR were used to screen the street homeless, undocumented foreigners, and facility homeless, and a portable mobile CXR was used for bed space apartment users. Identifiable repeatedly followed-up screen-

Figure 1. Flow chart for screening participants with chest X-ray (CXR). TB: tuberculosis; AFB: acid-fast bacillus.

Figure 2. The distribution of homeless people by age and type.

Table 1. General characteristics of the screened homeless confirmed as tuberculosis

Homeless type	Characteristic			Confirmed pulmonary tuberculosis	
	Estimated number	Actual no. screened (%)	Sex, male:female	No. (%)	Prevalence (/100,000)
Total cases		17,713 (100.00)	13,182:4,531	29 (0.16)	164
Street homeless	1,595	1,836 (10.37)	1,648:188	10 (0.54)	545
Facility workers	NA	1,109 (6.26)	649:460	1 (0.09)	90
Undocumented foreigner	NA	3,677 (20.76)	2,458:1,219	4 (0.11)	109
Facility homeless	7,361	6,619 (37.37)	4,837:1,782	3 (0.05)	45
Bed space apartment users	5,448	4,472 (25.25)	3,590:882	11 (0.25)	246

Numbers in brackets in reading classification are confirmed cases of tuberculosis.
NA: not available.

Table 2. Radiologic reading classification based on homeless type

Homeless type	Actual no. screened	Radiologic reading classification											
		Significant tuberculosis findings								Nonsignificant tuberculosis findings			
		Suspected tuberculosis	Prev., %	Inactive	Prev., %	Observation required*	Prev.,%	Total no.	Prev., %	Normal	Prev., %	Other significant lung disease	Prev., %
Total cases	17,713	40 (5)	0.23	3,077 (19)	17.37	79 (5)	0.45	3,196 (29)	18.04	13,829 (0)	78.0	688 (0)	3.88
Street homeless	1,836	6 (2)	0.33	434 (7)	23.64	12 (1)	0.65	452 (10)	24.62	1,307 (0)	71.2	77 (0)	4.19
Facility workers	1,109	0 (0)	0.00	56 (1)	5.05	0 (0)	0.00	56 (1)	5.05	1,039 (0)	93.6	14 (0)	1.26
Undocumented foreigner	3,677	5 (2)	0.14	137 (2)	3.73	10 (0)	0.27	152 (4)	4.13	3,450 (0)	93.8	75 (0)	2.04
Facility homeless	6,619	9 (0)	0.14	1,415 (3)	21.38	19 (0)	0.29	1,443 (3)	21.80	4,872 (0)	73.6	304 (0)	4.59
Bed space apartment users	4,472	20 (1)	0.45	1,035 (6)	23.14	38 (4)	0.85	1,093 (11)	24.44	3,161 (0)	70.6	218 (0)	4.87

Numbers in parenthesis in radiologic reading classification are confirmed cases of tuberculosis.
*Represents uncertain tuberculosis with undefined activity.
Prev.: prevalence.

ing cases were excluded, resulting in 17,713 cases for analysis.

The anonymous data collection forms from the central KNTA office were distributed to all regional offices, and all corrected clean data including most recent AFB culture results were analyzed after radiologic reading results were categorized by investigators.

3. Statistical analysis

All analyses were performed using R software version 4.2.1 (R Foundation for Statistical Computing, Vienna, Austria). A chi-square test was used to determine differences in CXR category between the homeless subjects with TB and the general population. Multivariable analysis with logistic regression was used to determine the factors associated with suggested TB and confirmed TB among the homeless. Exact binomial tests were used to compare the TB confirmation rates based on age between homeless subjects in the 2021 general health screening data[10,11]. All tests for significance were two-sided. The statistical significance was set at p-value of 0.05.

Results

1. General characteristics of homeless people in TB screening

The homeless subjects were classified as follows: street homeless, facility workers, undocumented foreigners, homeless persons in facilities, and bed space apartment users (Table 1). Among the total 17,713 homeless persons, the largest number was homeless persons in facilities (6,619, 37.37%). Figure 2 shows the distribution of homeless individuals based on age and residence type. The number of homeless individuals tended to increase with age: 33 (15.79%), <19 years; 1,044 (2.78%), 20–29 years; 1,939 (4.64%), 30–39 years; 2,737 (13.22%), 40–49 years; 4,438 (24.81%), 50–59 years; and 7,522 (35.93%), >60 years. Furthermore, the number of street homeless and facility homeless were highest in the >60 years group, while the number of undocumented foreigners was highest in the 30–39 years group.

2. Results of TB screening in homeless people

Classification based on CXR was divided into significant and nonsignificant TB findings (Table 2). The significant TB findings consisted of suggested TB, inactive TB, and observation required, and nonsignificant TB consisted of normal and other significant lung diseases. Under significant TB findings, inactive TB was most common in 3,077 cases (17.37%); 19 were confirmed

as TB. There were five cases of 40 cases (0.23%) of suggested TB, and five of 79 cases (0.45%) of observation required. There were 29 cases of confirmed pulmonary TB, and the prevalence was highest in the street homeless (545 of 100,000 persons). Statistically significant differences were found in the age distribution among suggested TB, observation required, and inactive TB groups (p<0.01). The prevalence of confirmed TB of the homeless compared with the general population based on age group is shown in Figure 3[12]. In the homeless, the lowest prevalence of TB was 96 of 100,000 persons in the 20–29 years group, and the highest prevalence of TB was 226 of 100,000 persons in the >60 years group. The TB prevalence in the homeless increased sharply after 50 years of age (Figure 3).

3. Analysis of homeless with suggested TB

The factors associated with significant TB on CXR among the homeless were analyzed using univariable and multivariable analysis (Table 3). The adjusted odds ratio (aOR) from the multivariable analysis was highest in bed space apartment users compared with undocumented foreigners (2.68; 95% confidence interval [CI], 2.01 to 3.56; p<0.001). For female gender, the aOR was 0.65 (95% CI, 0.58 to 0.73; p<0.001) compared with male, and analysis based on age group showed significantly higher aOR in the 50s (aOR, 1.57; 95% CI, 1.32 to 1.87; p<0.001) and 60s (aOR, 2.69; 95% CI, 2.29 to 3.17; p<0.001) than in the 40s.

Results of the homeless TB screening were compared with the national general health screening (Table 4). In all age groups older than 20 years, the prevalence of suggested TB in the homeless was significantly

Figure 3. The prevalence of confirmed tuberculosis of the homeless and the general population according to age groups.
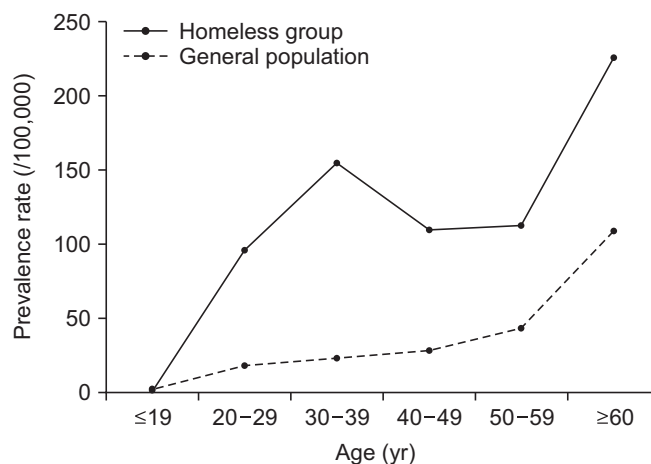
Table 3. Factors related to presumed tuberculosis on chest X-ray* among the homeless

Variable	Univariable analysis		Multivariable analysis	
	OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Classification				
Undocumented foreigner	Reference		Reference	
Street homeless	7.69 (5.85–10.11)	<0.001	2.95 (2.2–3.98)	<0.001
Facility workers	1.25 (0.87–1.81)	0.230	1.15 (0.79–1.7)	0.465
Facility homeless	6.56 (5.07–8.5)	<0.001	2.57 (1.94–3.4)	<0.001
Bed space apartment users	7.61 (5.86–9.89)	<0.001	2.68 (2.01–3.56)	<0.001
Sex				
Male	Reference		Reference	
Female	0.53 (0.48–0.59)	<0.001	0.65 (0.58–0.73)	<0.001
Age, yr				
≤19	0 (0–Inf)	0.921	0 (0–Inf)	0.92
20–29	0.28 (0.17–0.47)	<0.001	0.43 (0.25–0.74)	0.002
30–39	0.38 (0.28–0.52)	<0.001	0.49 (0.35–0.69)	<0.001
40–49	Reference		Reference	
50–59	1.92 (1.6–2.26)	<0.001	1.57 (1.32–1.87)	<0.001
≥60	3.38 (2.92–3.92)	<0.001	2.69 (2.29–3.17)	<0.001
Cough				
No	Reference		Reference	
Yes	2.51 (2.09–3.01)	<0.001	1.46 (1.15–1.84)	0.002
Sputum				
No	Reference		Reference	
Yes	1.78 (1.49–2.12)	<0.001	1.04 (0.84–1.3)	0.716
Past history of TB				
No	Reference		Reference	
Yes	10.02 (8.92–11.27)	<0.001	8.27 (7.31–9.36)	<0.001
Do not know	1.6 (1.3–1.96)	<0.001	1.69 (1.36–2.09)	<0.001
BMI	0.89 (0.88–0.9)	<0.001	0.91 (0.9–0.92)	<0.001

*Tuberculosis on chest X-ray includes suspected tuberculosis, observation required, and inactive tuberculosis.
OR: odds ratio; CI: confidence interval; Inf: infinite; TB: tuberculosis; BMI: body mass index.

higher than in the national general health screening. In comparison with the national general health screening, the prevalence of TB in the screened homeless was significantly higher in the age groups older than 20 years. The highest aOR (5.15) was in the 40–49 group (95% CI, 3.01 to 8.61), followed by the 20–29 group (aOR, 5.07; 95% CI, 1.98 to 12.26).

4. Confirmed TB and inactive TB in health screening of homeless people

In multivariable analysis to identify factors that affect confirmed TB in screening of the homeless (Table 5), difference was not observed based on screening category, age, or respiratory symptoms (p>0.05). Body mass index (BMI) negatively correlated with TB (aOR, 0.86; 95% CI, 0.73 to 0.99). Subjects with suggested TB and individuals requiring observation had significantly higher aOR (18.29; 95% CI, 5.28 to 63.41; p<0.001 and 10.07; 95% CI, 3.44 to 29.46; p<0.001, respectively) compared with individuals with inactive TB. Therefore, low BMI can be considered as a factor significantly related to TB in homeless people.

Discussion

Homeless people with lower BMI showing inactive

Table 4. Comparison of suggested tuberculosis on chest X-ray between the homeless and general population based on age groups

Variable	Suggested tuberculosis* on homeless CXR screening		General health screening			
	Total	Presence (%)	Total	Presence (%)	Unadjusted OR (95% CI)	p-value
Total	17,713	119 (0.67)	6,814,938	9,802 (0.14)	4.70 (3.91–5.64)	<0.001
Age group, yr						
≤19	33	0	3,347	2 (0.06)	0 (0–356.31)	1.000
20–29	1,044	5 (0.48)	389,213	369 (0.09)	5.07 (1.98–12.26)	0.003
30–39	1,939	4 (0.21)	938,595	717 (0.08)	2.7 (0.92–7.05)	0.064
40–49	2,737	15 (0.55)	1,526,672	1,622 (0.11)	5.18 (3.02–8.66)	<0.001
50–59	4,438	25 (0.56)	1,580,066	2,406 (0.15)	3.71 (2.49–5.52)	<0.001
≥60	7,522	70 (0.93)	2,377,045	4,686 (0.2)	4.76 (3.74–6.04)	<0.001

*Suspected tuberculosis and observation required on chest X-ray.
CXR: chest X-ray; OR: odds ratio; CI: confidence interval.

TB or possible TB on CXR should be further assessed to confirm active pulmonary TB. Considering the high TB prevalence rate of 246 per 100,000 people with a relatively lower presumed screening rate of 82.0%, aggressive TB screening must be conducted for the bed space apartment users as well as the unscreened homeless. However, TB screening for the street homeless should be continued due to the highest TB prevalence observed in this study (545 per 100,000 persons). An accurate estimate of undocumented foreigners with TB should also be established based on the prevalence of 109 per 100,000 persons observed in this study.

TB incidence and BMI were reported to show a linear relationship[13]. The present study confirms that low BMI in the homeless is significantly related to TB. Among the subjects showing significant TB findings on CXR, BMI was significantly lower at 22.50 compared with the BMI of 23.76 in the other groups. Furthermore, the street homeless exhibiting the highest disease prevalence, had a significantly lower BMI of 23.25 compared with undocumented foreigners and facility homeless. Because the homeless population is exposed to irregular meals and poor environmental conditions and show a lower BMI distribution compared with the general population, a concurrent nutritional support program as an incentive combined with TB screening would be effective for improving treatment adherence[14] and the nutritional status of the homeless.

In a total of 17,713 cases, 29 were confirmed TB, with a prevalence of 164 of 100,000 persons. CXR findings of inactive TB showed the highest prevalence with 19 of 3,077 cases, indicating that aggressive further workup is recommended for this group. This suggestion could be applied in the general national health screening[15], where a previous study confirmed a significantly higher proportion of inactive TB in the confirmed TB group at 2,761 (24.6%) than in a control group at 3,072 (15.9%; p<0.00001)[10]. Considering the recent advances in diagnostic technology, findings suggestive of TB on CXR could be determined using deep learning algorithms[16]. However, for homeless individuals without a fixed residence or financial means for diagnostic examination or treatment, adhering to additional examinations and treatment plans can be challenging. Several studies[17,18] showed a higher likelihood of incomplete treatment or treatment delay in the homeless population. Therefore, in cases where inactive TB is observed on CXR, it is essential to exclude active TB, particularly in homeless individuals. The need for personalized care strategies for TB treatment among the homeless should be emphasized and implemented in policies regarding vulnerable groups.

Table 1 shows that roughly 89% of the facility homeless and presumed 82% of the bed space apartment users were screened in the 2021 TB screening project. Although more than the estimated numbers of street homeless were screened, the exact number is questionable due to the difficulty in identifying this population[5]. Certain groups, such as undocumented foreigners pose challenges in verifying their residency or identity, requiring significant efforts to obtain accurate figures[19,20]. Verifying the precise number of individuals in these groups is essential to ensure accurate data collection and understanding of TB in the homeless population to create effective policies.

This study had several limitations. First, obtaining

Table 5. Factors related to confirmed tuberculosis among homeless people

Comparison	Adjusted OR (95% CI)	p-value
Classification		
Undocumented foreigners	Reference	
Street homeless	3.06 (0.19–49.68)	0.432
Facility workers	6.51 (0.23–186.21)	0.274
Facility homeless	0.35 (0.02–6.57)	0.487
Bed space apartment users	1.26 (0.08–20.29)	0.872
Sex		
Male	Reference	
Female	0.47 (0.1–2.28)	0.346
Age, yr		
≤19	2.4 (0–Inf)	1.000
20–29	7.14 (0.34–149.98)	0.206
30–39	2.35 (0.18–30.45)	0.514
40–49	Reference	
50–59	0.91 (0.16–5.11)	0.914
≥60	1.43 (0.29–7.01)	0.656
Cough		
No	Reference	
Yes	1.76 (0.42–7.4)	0.437
Sputum		
No	Reference	
Yes	2.12 (0.51–8.9)	0.304
Past history of TB		
No	Reference	
Yes	0.76 (0.3–1.92)	0.559
Unknown	1.11 (0.14–8.96)	0.921
BMI	0.86 (0.73–0.99)	0.048
CXR result		
Inactive TB	Reference	
Suspected TB	18.29 (5.28–63.41)	<0.0001
Observation required	10.07 (3.44–29.46)	<0.0001

OR: odds ratio; CI: confidence interval; TB: tuberculosis; BMI: body mass index; CXR: chest X-ray.

accurate data, including treatment histories and medical insurance coverage, was difficult because the screening projects had not been planned for academic analysis, and some data, such as past treatment history and health behaviors, depended on individual memory and cognition. Second, an additional confirmative sputum AFB study was conducted only for subjects with significant TB findings on CXR. Third, Xpert MTB/RIF assay for diagnosing rifampin-resistant TB with rapid turnaround time and high sensitivity were not routine-

ly used. Therefore, emerging molecular tests could be considered in a future study. Last, adherence to treatment could not be continuously monitored[21], and the final treatment outcome could not be identified. Therefore, for future screening or treatment programs targeting the homeless population, it will be crucial to establish a review system for past diagnosis and treatment history and a comprehensive monitoring system to improve treatment adherence.

The results of this research confirmed a higher prev-

alence of TB among the homeless population (164 per 100,000 individuals) compared with the general population in Korea. Furthermore, considering the higher TB confirmation rate among homeless people with inactive or suggested TB on CXR as well as individuals with a low BMI, aggressive confirmatory tests are needed.

Authors' Contributions

Conceptualization: Han H, Lee SH. Formal analysis: Han H, Kang Y, Choi H, Kim HJ, Lee SH. Data curation: Han H, Lee JH, Choi H, Kim HJ, Lee SH. Project administration: Lee SH. Writing - original draft preparation: Han H, Lee JH, Lee SH. Writing - review and editing: Han H, Lee JH, Chung SJ, Kim BK, Kim HJ, Lee SH. Approval of final manuscript: all authors.

Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

Funding

Supplementary Material

Supplementary material can be found in the journal homepage (http://www.e-trd.org).

Supplementary Table S1. Radiologic classification of chest X-rays for tuberculosis screening.

References

1. Min J, Kim HW, Kim JS. Tuberculosis: Republic of Korea, 2021. Tuberc Respir Dis (Seoul) 2023;86:67-9.
2. Korea Disease Control Prevention Agency. 2022 National tuberculosis management guideline. Cheongju: Korea Disease Control Prevention Agency; 2021.
3. Murray CJ, Lopez AD. Global mortality, disability, and the contribution of risk factors: Global Burden of Disease Study. Lancet 1997;349:1436-42.
4. World Health Organization. Systematic screening for active tuberculosis: principles and recommendations [Internet]. Geneva: WHO; 2013 [cited 2024 May 15]. Available from: https://apps.who.int/iris/handle/10665/84971.
5. Lim DY, Lee TJ, Ha ES, Lee BJ, Nam YJ, Nam KC, et al. 2021 Homeless survey [Internet]. Sejong: Korea Institute for Health and Social Affairs; 2021 [cited 2024 May 15]. Available from: https://www.mohw.go.kr/board.es?mid=a10411010100&bid=0019.
6. World Health Organization. Implementing the end TB strategy: the essentials. Geneva: WHO; 2015.
7. Choi YA. Directly observed treatment in homeless people. Seoul: Seoul Dasiseogi Support Center; 2013.
8. Park S, Sung C, Choi H, Lee YW, Kang Y, Kim HJ, et al. Comparison of active tuberculosis case finding strategies for immigrants in South Korea: epidemiology and cost-effectiveness analysis. PLoS One 2023;18:e0283414.
9. Nishtar T, Burki S, Ahmad FS, Ahmad T. Diagnostic accuracy of computer aided reading of chest X-ray in screening for pulmonary tuberculosis in comparison with GeneXpert. Pak J Med Sci 2022;38:62-8.
10. Oh IH, Lee SH. Investigation for tuberculosis screening and management policy to decrease the burden of tuberculosis based on health care big data. Cheongju: Korea Health Industry Development Institute; 2023.
11. Kim J, Lee H, In H, Kim Y. Characteristics of the notified tuberculosis: the Republic of Korea, 2021. Public Health Wkly Rep 2022;15:729-46.
12. Korea Disease Control and Prevention Agency. 11-1790387-000332-10: Annual report on the notified tuberculosis in Korea, 2022 [Internet]. Cheongju: Korea Disease Control and Prevention Agency; 2022 [cited 2024 May 15]. Available from: https://www.kdca.go.kr/board/board.es?mid=a31001000000&bid=0130.
13. Lonnroth K, Williams BG, Cegielski P, Dye C. A consistent log-linear relationship between tuberculosis incidence and body mass index. Int J Epidemiol 2010;39:149-55.
14. Sharma N, Basu S, Chopra KK. Achieving TB elimination in India: the role of latent TB management. Indian J Tuberc 2019;66:30-3.
15. Kim HS, Shin DW, Lee WC, Kim YT, Cho B. National screening program for transitional ages in Korea: a new screening for strengthening primary prevention and follow-up care. J Korean Med Sci 2012;27 Suppl:S70-5.
16. Choi YR, Yoon SH, Kim J, Yoo JY, Kim H, Jin KN. Chest radiography of tuberculosis: determination of activity using deep learning algorithm. Tuberc Respir Dis (Seoul) 2023;86:226-33.
17. Heo DJ, Min HG, Lee HH. The clinical characteristics and predictors of treatment success of pulmonary tuberculosis in homeless persons at a public hospital in Busan. Korean J Fam Med 2012;33:372-80.
18. Kim Y, Lee JY, Jeong I, Kim J, Kim J, Han J, et al. Factors related to successful tuberculosis treatment in vulnerable groups. Korean J Med 2022;97:50-9.

19. Nam KC. A study on homeless monitoring in Korea. Health Soc Welf Rev 2011;31:158-93.

20. Chong SW, Park JI. Legal tasks to promote human rights of undocumented migrants. J Legis Res 2016;51:409-49.

21. Burman WJ, Cohn DL, Rietmeijer CA, Judson FN, Sbarbaro JA, Reves RR. Noncompliance with directly observed therapy for tuberculosis: epidemiology and effect on the outcome of treatment. Chest 1997;111:1168-73.