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Indoor air bacterial quality and associated factors in prison inmate cells of East Hararghe Zone and Harari Regional State, Eastern Ethiopia

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ABSTRACT

Background: Bacterial indoor air load refers to the level of bacteria within and around dwellings and other structures. Pathogens, bacterial cell fragments, and bacterial organisms' byproducts can all pose major issues indoors, especially in prison inmate cells. However, there is lack of data on bacterial load and contributing factors in the East Hararghe zone and Harari regional state. The lack of studies on microbiological indoor air quality in prisons with contributing factors will therefore be filled by this investigation.

Objectives: The study aimed to assess bacterial indoor air load and contributing factors in prison inmate cells from October 1 to October 30, 2020.

Methodology: An institutional cross-sectional study was employed. All of the prisons in the East Hararghe zone and the Harari regional state served as the study's and source population. 62 prison cells were used in the investigation. Samples were obtained using the passively settling plate technique. The data were evaluated through the use of SPSS statistical software, Excel, and the statistical procedures of ANOVA, correlation, and chi-square test.

Results: The maximum and minimum bacterial loads were recorded at 8:00 am (3027 CFU/m^3) and 2:00 pm (1048 (CFU/m^3) respectively. The correlation between the temperature and bacterial load was strongly positive (r = 0.680, p = 0.047), and the correlation of the moisture content and bacterial load was strongly negative (r = -0.671, p = 0.039).

Conclusion: The levels of bacteria were higher than the guideline (2000 CFU/m^3). While the relative humidity of indoor air was negatively correlated with bacterial load, temperature and bacterial load were significantly positively correlated. Harari regional state and East Hararghe zone prison commissions should be alarmed to alleviate these problems. The building standards need to be completely updated to the latest standards.

Key words: Bacterial load, Indoor air, Prison inmate cell, Settle plate method

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Data availability statement: Almost all the data are included in this study. However, additional data will be available from the corresponding author upon reasonable request.

Conflict of interest: The authors declare that they have no conflicts of interest.

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Introduction

Airborne pollutants and health of human beings are adversely affected by undesired chemicals and particles in the air [1]. The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), defines acceptable Indoor Air Quality as "air in which there are no known contaminants at harmful concentrations as determined by cognizant authorities and with which a substantial majority (90% or more) of the people exposed do not express dissatisfaction" [2].

A person's ability to lead a healthy life and their general well-being is greatly influenced by the air quality within their residences, places of business, jails, hospitals, and other public and private buildings. Indoor air pollution is a significant issue that affects people's daily life [3]. According to the 2002 World Health Organization report, the health effects of indoor air quality were significant. 2.7% of the global burden of disease was directly caused by indoor air pollutants [4]. Effective remedial measures are desperately required to address the issue of indoor air quality. The main strategies for enhancing indoor air quality in the majority of buildings include source management, filtration, and the use of ventilation to disperse the contaminants [5].

Numerous bacteria can develop indoors when there is enough moisture, which leads to bacterial pollution of indoor air. They also consist of a diverse range of allergens and microorganisms that are contagious. Dampness, insufficient ventilation, temperature and high levels of moisture are the main determinants of the existence of numerous bacterial agents in an internal environment and allergies and respiratory problems are clinically linked to exposure to bacterial pollutants [6].

Under state authority, a prison is a place where prisoners are detained against their will and denied a range of liberties. Because they have restricted access to associations or jobs, prisoners will occasionally spend a lot of time in their cells [7]. Prisons are built without hygienic amenities like laundry, soap, or water. Major contributing causes to the development of diseases in prisons include overcrowding, sharing meals, restrooms, showers, and cells; poor personal hygiene; improper food handling techniques; inadequate ventilation; a lack of knowledge; and restricted access for case diagnosis and treatment. Prisoners' health, safety, and economic growth are all impacted by this issue with prisoner health, as is the population at large [8]. A greater interest in emergency and disease dissemination has arisen because of the crowded conditions of prisons inmates and the increased exposure of humans to microbiological indoor air pollutants or pathogens [9]. Prisoners may be exposed to high concentrations of air pollution since they spend a significant amount of time indoors. Smaller indoor-air mixing volumes caused by the overcrowding in prison cells facilitate the easier transmission of infectious diseases from one person to another [10].

There is limited data studied on bacterial indoor air loads and associated factors in prison facilities of East Hararghe and Harari regional states. For better and more timely control and prevention of short and long term inmate exposure to biological hazards that might pose the aforementioned human health risks, it is crucial to investigate the indoor air microbial quality condition around various building premises, such as public libraries, healthcare facilities, schools, university dormitories, and others. The lack of information on the bacterial indoor air load in prisons and its contributing factors is thus filled in by this discovery, which also provides guidance for the inmates' indoor air quality.

Methods

Study area and period

Between October 1, 2020, and October 30, 2020, an institutional-based cross-sectional study was conducted in the prisons located in the East Harage zone and in the Harari regional state, Eastern Ethiopia, namely in the Adele town, Girawa town, Deder town, Harar city, and Gursum town. All the six jails of East Harage Zone and Harari Regional State were addressed in the research.

Source and study population

All inmate cells in the prison were the source and study populations.

Inclusion and exclusion criteria

Every jail cell used by inmates on a long-term basis was chosen, however non-operational cells were not included in the research.

Sample size determination

The sample was determined based on this formula:

$$n = \frac{(Z\alpha/2)^2\ \pi(1-\pi)}{d^2}$$

Where n = sample size, $(Z\alpha/2) = 1.96$, $(1.96)^2 = 3.8416$
$\pi = 0.745$ and $d^2 = 0.05$
$\pi = 0.745$ this proportion was taken from (13).

$$n = \frac{3.8416 \times 0.755 \times 0.245}{(0.05)^2} = 284$$

The total number of inmate cells was 62, and then the reduction formula was used.

$$\text{Thus} \quad n = \frac{n_\circ}{1 + \frac{n_\circ - 1}{N}} \rightarrow \frac{284}{1 + \frac{284 - 1}{62}} = 51$$

Still, each and every cell in the study area was taken in the study. The total number of inmate cells in each prison was as follows: Harari region Harar town (14), East Hrarghe zone Harar branch (12), East Hararghe zone Adele branch (5), Deder branch (12), Gursum branch (5) and Girawa branch (14) with total rooms of 62 inmate cells studied.

Sample taking procedures

As it was feasible to engage all inmate cells in the assessment, all 62 inmate cells from East Hararghe and Harari prisons were taken.

Data collection methods

The bacterial sample was passively collected using the settle plate method (also called Koch sedimentation plates). The prepared blood agar media was poured into the labeled 9-cm Petri dish, covered with the lids, and taken to the prison inmate cells through the use of an ice box to prevent cross contamination. After opening the Petri dish, it was positioned sideways, one meter above the floor - the human breathing zone - and one meter away from any walls or additional obstacles. It was then left exposed for one hour (1/1/1 principle) [14]. The times of data collection were 8:00 am and 2:00 pm each day. The exposed petri dish and the control medium were taken to the Haramaya University College of Health and Medical Science's medical laboratory, and incubated at 37 °C for 24 hours.

To examine environmental factors, direct observation using checklists prepared with the goal in mind was performed. To determine the inmate cell area, window area ratio, and crowding index (m^2/person), measurements were made. An air quality monitoring apparatus (an electric aerator sampler instrument) was used to measure the velocity of air, temperature, and moisture content, or humidity, and an interview was used to assess the frequency of cleaning.

Variable

The dependent variable was bacterial colonies in prison inmate cells expressed as CFU/m^3 and temperatures, humidity/moisture content, ventilation, air velocity, cleanliness of the space and how often it is cleaned, number of people inside (crowdedness), time of data collection (morning and afternoon), and occupant behavior (chewing, smoking, and physical activities) are the independent variables.

Data quality control

To maintain the quality of the data, the nutrient medium for bacterial growth was sterilized at 121°C for 15 minutes prior to data collection to prevent bacterial contamination. Data were collected aseptically through the use of sterile gloves to prevent media contamination. To ensure the maintenance of data collection quality, procedural control groups were implemented.

Methods of data analysis

Following the specimen's exposure for one hour, the petri dish was sealed, brought to the Haramaya University Medical Laboratory, and incubated at 37 °C for 24 hours. After the 24-hour incubation period, the bacterial load was calculated using the following formula to determine colony forming units (CFU) and CFU/m^3.

$n = \frac{5a \times 10^4}{bt}$ [15]. Where N=bacterial CFU/m^3 of indoor air; a = the number of colony forming unit per Petri dish; b = dish surface (cm^2); and t = exposure time (minutes). SPSS version 23 and Microsoft Excel 2013 software were used for data analysis. One-way ANOVA, chi-square, and Pearson correlation statistical methods were used. Finally, the information was sorted, cleaned, analyzed, and presented using graphs, tables, and text.

Result

Microbial indoor air quality in inmate cells of prisons

Based on this study, the highest bacterial load (3027 CFU/m^3) was recorded at 8:00 am, while the lowest bacterial load (1048 CFU/m^3) was recorded at 2:00 pm (Table 1 and Figure 1).

The mean bacterial loads of all the sampling sites were 2333 CFU/m^3 and 2377 CFU/m^3 in the morning and afternoon, respectively (Table 2).

Table 1. Descriptive summary of bacterial loads in prison inmate cells, in Eastern Hararghe and Harari regional state, Eastern Ethiopia, 2020 (n = 62).

	Harari region		East Hararghe Harar branch		Adele		Deder		Gursum		Girawa	
Statistics	**8:00am**	**2:00pm**	**8:00am**	**2:00pm**	**8:00am**	**2:00pm**	**8:00am**	**2:00pm**	**8:00am**	**2:00pm**	**8:00am**	**2:00pm**
Mean	2229	2359	2469	2372	2451	2668	2143	2125	2487	2508	2415	2466
Median	2326.5	2359	2496.5	2339.5	2582	2739	2247.5	2228	2818	2477	2444.5	2437.5
Maximum	2844	2896	2949	2792	3027	2792	2634	2621	3014	2870	2896	2818
Minimum	1429	1953	2058	1992	1429	2346	1284	1048	1337	2018	1691	2123
Stdev.	470.6	256.7	267.5	252.5	618.7	183.4	388.2	443.3	689.9	334.5	320.7	196.1
Variance	221435.2	65906.2	71535.2	63765.7	382729.7	33633.3	150680	196529.7	476064.3	111890.7	102871	38436.9

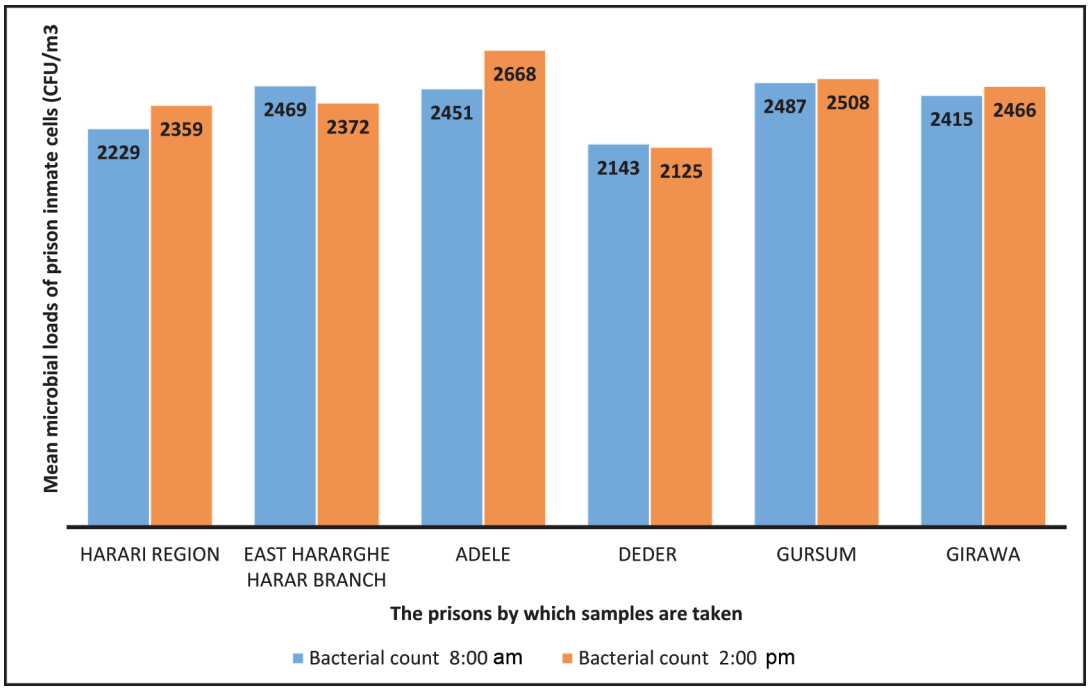

Figure 1. Mean bacterial loads in Harari Regional State and East Hararghe Zone prison inmate cells, Eastern Ethiopia, 2020 (n = 62).

This study identifies that the concentrations of bacterial loads were greater than 2000 CFU/m^3, which was a very high pollution degree (Table 3).

One-way ANOVA were done to evaluate the mean difference in bacterial count among sampling sites. This shows no mean difference in bacterial load among different sampling sites (N = 62, Df = 61, p = 0.43, $F_{calculated}$ = 0.614, and F*critical* =4.001) (Table 4).

Determinant factors associated with bacterial Indoor Air Quality

The bacterial loads of the inmate cells in prisons may be positively or negatively affected by several environmental factors. The average temperature of prison inmate cells was 21.06 °C (69.9 °F) while the minimum and maximum temperatures recorded were 9.7°C (49.4 °F) and 28.8°C (83.9 °F), respectively. The measured inmate cells' mean, lowest, and maximum relative humidity values were 63.05%, 45.7%, and

Table 2. Total mean bacterial loads in Harari Regional State and East Hararghe Zone prison inmate cells, Eastern Ethiopia, 2020 (n = 62).

Variables	N	Minimum	Maximum	Mean	Std. Deviation
Bacterial colony in the morning	62	1284	3014	2333	401
Bacterial colony at the afternoon	62	1048	2896	2377	318
Valid N (list wise)	62				

Table 3. Evaluation of the bacterial air quality in prisoner cells, based on sanitary standards for non-industrial premises, in Harari Regional State and East Hararghe Zone, Eastern Ethiopia, 2020 (n = 62).

			Harari region		East Hararghe Harar branch		Adele		Deder		Gursum		Girawa	
Group of microbes	**Range**	**Pollution degree**	**8:00 am**	**2:00 pm**	**8:00 am**	**2:00 pm**	**8:00 am**	**2:00 pm**	**8:00 am**	**2:00 pm**	**8:00 am**	**2:00 pm**	**8:00 am**	**2:00 pm**
Bacterial	<50	Very low												
	51-100	Low												
	101-500	Intermediate												
	501-2000	High												
	>2000	Very high	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table 4. One way ANOVA result for mean bacterial load between sampling sites in Harari Regional State and East Hararghe Zone prison inmate cells, Eastern Ethiopia, 2020 (n = 62).

Summary of Bacterial Load						
Groups	**Inmate cells**	**Total loads**	**Average**	**Variance**		
Harari regional state	14	32118	2294	108866		
East Hararghe zone	48	114089	2377	123981		
ANOVA						
Source of Variation	SS	Df	MS	F	P	F crit
Between Groups	74149	1	74149	0.614	0.4362	4.001
Within Groups	7242376	60	120706			
Total	7316525	61				

82.1%, respectively. Crowding, air velocity, the people chewing chat, the number of smokers, and the people participating in data collection are among the factors described in Table 5.

According to this study, only 5 (8.1%) of the prison cells had a size greater than 4 m^2 per individual, which is recorded in the East Hararghe Zone. 100% of the prisoner cells at Harari Regional State Prison have a population density of less than 4 square meters per inmate. 57 (91.9%) of the prisons in the Harari regional state and East Hararghe Zone were overcrowded, with a crowding index of below 4 m^2 per prisoner (Figure 2).

The paired sample t-test was employed to verify that the bacterial loads in the jails are identical in the morning (8:00 am) and afternoon (2:00 pm). According to the results (Table 6), there was no difference in bacterial load in the morning and the afternoon (t = −1.271, Df = 61, and p = 0.20).

Table 5. Statistical summary of Environmental factors in Harari Regional State and East Hararghe Zone prison inmate cells, Eastern Ethiopia, 2020 (n = 62).

Contributing factors	N	Minimum	Maximum	Mean	Std. deviation	Variance
Crowdedness (m2/person)	62	1.1	10	2.3613	1.41842	2.012
Temperature (of)	62	49.4	83.9	69.8855	7.70401	59.352
Relative humidity (%)	62	45.7	82.1	63.05	6.73583	45.371
Velocity of air (m/s)	62	2	9	5.0645	1.48071	2.192
Number of prisoners	62	5	37	23	6.49771	42.22
Smokers (in number)	62	0	14	2	2.71515	7.372
Chewers (in number)	62	0	27	7	6.49397	42.172
Valid N (listwise)	62					

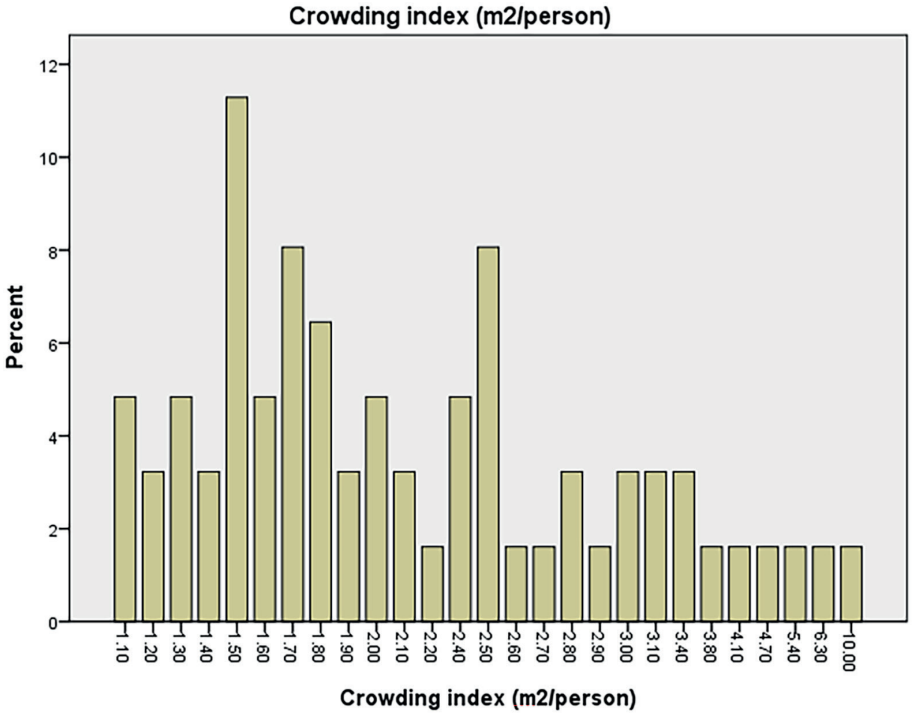

Figure 2. Frequency percentage of crowding index in Harari Regional State and East Hararghe Zone prison inmate cells, Eastern Ethiopia, 2020 (n = 62).

Table 6. Pearson's correlation between environmental conditions and indoor bacterial counts in jail inmate cells in East Hararghe Zone and Harari Regional State, Eastern Ethiopia, 2020 (n = 62).

				95% Confidence interval of the Difference				
	Mean	Std. deviation	Std. error mean	Lower	Upper	T	Df.	Stg.
Bacterial load at 8:00 am bacterial loads at 2:00 pm	-.06452	.39963	.05075	-.19946	.07043	-1.271	61	.208

Table 7. Pearson's correlation between indoor bacterial concentrations with environmental factors, in Harari Regional State and East Hararghe Zone prison inmate cells, Eastern Ethiopia, 2020 (n = 62).

		Temperature	Relative humidity	Velocity of air	Number of individuals	Chewing chat	Number of smokers	Physical activities	Crowdedness
Temperature	Pearson Correlation		1						
	Sig. (2-tailed)								
Relative humidity	Pearson Correlation	-.200	1						
	Sig. (2-tailed)	.118							
Velocity of air	Pearson Correlation	-.319*	.019	1					
	Sig. (2-tailed)	.011	.884						
Number of individuals	Pearson Correlation	-.322*	.117	.311*	1				
	Sig. (2-tailed)	.011	.366	.014					
Chewing chat	Pearson Correlation	-.408**	-.052	.138	.554**	1			
	Sig. (2-tailed)	.005	.733	.368	.000				
Number of smokers	Pearson Correlation	-.396*	.069	.158	.432*	.542**	1		
	Sig. (2-tailed)	.041	.733	.432	.024	.004			
Physical activities	Pearson Correlation	-.327	-.529	.866	.961	-1.000**	.	1	
	Sig. (2-tailed)	.788	.645	.333	.179	.	.		
Crowdedness	Pearson Correlation	.036	-.103	-.021	-.171	-.183	-.010	-.569	1
	Sig. (2-tailed)	.783	.428	.871	.184	.229	.959	.614	
Bacterial load	Pearson Correlation	.680*	-.671*	-.737*	.715*	-.158	.739*	.998*	-.603*
	Sig. (2-tailed)	.047	.039	.029	.037	.300	.049	.044	.043

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

A Pearson correlation was used to examine the relationships between variables like temperature, relative humidity, air velocity, the number of inmates in each cell, the number of smokers, the number of individuals exercising, and the crowdedness of the inmate cells with bacterial loads. The Pearson's correlation shows that temperature and bacterial load have strong positive correlations (r = 0.680 and p = 0.047), whereas relative humidity and crowdedness have strong negative correlations (r = –0.671 and p = 0.03 and r = –0.603 and p = 0.043, respectively). Smokers in the inmate cell and exercise levels were strongly correlated with bacterial load (r = 0.739, p = 0.04; r = 0.998, p = 0.04), respectively; however, velocity of air was negatively correlated with bacterial load (r = –0.737, p = 0.029) (Table 7).

Table 8. Chi-square test to Environmental factors that may affect the bacterial loads in Harari Regional State and East Hararghe Zone prison inmate cells, Eastern Ethiopia, 2020 (n = 62).

	Bacterial loads	
Factors	**Degree of freedom (Df)**	**p**
Condition (openness) of window	1	0.79
Frequency of opening the window per day	2	0.04
Frequency of ventilation to work per time	1	0.04
Presence of visible waste on the ceiling	1	0.04
Cleanness of floor	1	0.03
Presence of un sanitized food and their products	1	0.01

In order to determine the association between environmental conditions and bacterial load, Fisher's exact test was used. The result obtained from Fisher's exact test describes that bacterial loads were associated with the frequency of window openings per day (Df = 2, P = 0.04), the presence of visible waste on the ceiling (Df = 1, P = 0.048), the cleanliness of the floor (Df = 1, P = 0.03), and the presence of unhygienic food and their products in the inmate cell (Df = 1, P = 0.01) (Table 8).

Discussion

The mean bacterial loads of this study were very high (2355 CFU/m^3) compared to different standards and studies. This study shows that the bacterial loads were much higher compared to the study done in school (1389 CFU/m^3) [21]. This may be as a result of the fact that in schools, students may not be residing at all times. The mean bacterial loads in a study done in Jimma town were 77081 CFU/m^3 [20], but our result is much lower than that of Jimma. This variation may be due to low ventilation status and a high number of inhabitants. Countries and institutions have their own types of standards for bacterial indoor air loads. Based on the government of Hong Kong Special Administrative Region Indoor Air Quality Management Group 2019, which states that the bacterial load for public places is excellent if it is <500 CFU/m^3 and good if it is < 1000 CFU/m^3, this study shows all the inmate cells were in the range of very high bacterial loads [16]. Based on the sanitary standards for non-industrial public institutions formulated by the European Commission in 1993, all prison inmate cells in this study were polluted with bacterial indoor air pollutants [17]. This may be because of poor sanitation conditions and a high crowding index in most of the prisons. There is evidence that there is no mean difference in bacterial count among different sampling sites. This may be because of the similarities in environmental conditions in all inmate cells, and some of the prisons are found in the same compound, which has the same environmental factors.

The study addresses temperature as one of the environmental factors affecting bacterial load. Based on the Hong Kong Environmental Protection Department, the temperature range for indoor air quality is 20–25.5 °C (68–77.9 °F) for excellent air quality and <25.5°C (77.9°F) for good air quality [18]. Based on this standard, the result of our study identifies that the mean temperatures of the inmate cells were within an excellent range of indoor air temperature. This compliance with the standard might be as a result of the presence of artificial and natural ventilation. A study done in the Jima Town prison administration shows that the temperature was significantly associated with bacterial loads [20]. Similarly, our study identified that temperature and bacterial load have strong positive correlations (r = 0.680 and p = 0.047). This similarity might be a result of the similarities in environmental factors like ventilation and weather conditions.

The crowding index of the inmate cells ranged from 1.1–10.0 m^2/person. This shows that many of the prisoners live in a very crowded inmate cell. The mean crowding index of the prison inmate cells was 2.36 m^2/person, which is below the recommended standard (4 m^2/ person) [17]. This disparity from the standards might be due to the absence of many prison inmate cells in the study setting. Crowdedness has strong negative correlations (r = –0.603 and p = 0.043) with bacterial loads. This is because exhaled air from many occupants can release bacterial aerosols into the indoor environment. The crowding index of

the study done in Jimma town prison administration was similarly significantly associated with bacterial loads [20]. This is because more people in the prison cells in each of the two locations may cause a release of bio aerosols that raises the concentration of bacteria.

Relative humidity in prison inmate cells was measured. The average and range of relative humidity were 63.05%, 45-82.1%, In accordance with the Canadian government, the recommended relative humidity ranges for summer and winter are 30–80% and 30–55%, respectively [18]. According to the American Society of Heating, Refrigerating, and Air-Conditioning Engineers, the normal relative humidity levels range from 40 to 60% in the summer and 30 to 60% in the winter [18]. The air's relative humidity in this investigation was higher than ASHRAE's criteria. Our study result shows slightly higher than the above standards, which can be a result of the high number of occupants and the presence of food items that can increase water vapor at higher temperatures. The higher relative humidity can decrease the number of bacterial loads by creating unfavorable conditions for bacteria, as it can create hypertonic conditions with bacterial cells. But the relative humidity in the standard is important for bacterial growth. Relative humidity has strong negative correlations ($r = -0.671$ and $p = 0.03$) with bacterial loads. This is almost similar to a study reported by Andualem et al. [3] where relative moderate to strong humidity was negatively correlated with total airborne bacteria in the afternoon ($r = -0.4014$) and in the morning ($r = -0.7034$), respectively.

The mean and range of air velocity was given as 5.06 m/s, and 2–9 m/s, respectively. According to WHO guidelines, air should move at a speed of 0.25 m/s. This result is far higher than the WHO recommendations for indoor air quality, which could lead to drought in the prisoner's cell [18]. This might be because of good natural and artificial ventilation. The study shows that the velocity of air was negatively correlated with bacterial load ($r = -0.737$, $p = 0.029$). As high air velocity is important for good air circulation, very high air velocity, as observed above, may decrease bacterial growth through the creation of drought in the classroom. The negative correlation between velocity of air and indoor airborne bacterial load was not consistent with what was expected since the relative humidity reported above didn't show drought.

Based on the outcomes of the paired t-test performed to assess the effect of data collection time on the bacterial load, there is no difference in the bacterial load in the morning and afternoon. According to a study done in Poland, the time of data collection influenced the number of microorganisms [19]. This deviation may be due to the constant number of occupants in our study both in the morning and afternoon, unlike that of the above study done in Poland, where the numbers of students vary in the morning and afternoon.

The number of smokers ($r = 0.739$, $p = 0.049$) in the study was strongly correlated with the bacterial loads in the prison. This means the smokers in the inmate cell were releasing bacterial aerosols into the indoor environment. But this study result contradicts a study by Vanker A. et al. [22] that smoking was not associated with bacterial load. This difference might be a result of temperature and other environmental factors that can favor bacterial growth in the inmate cells. The Khat chewing behaviors of the prisoners were not correlated with bacterial growth. The presence and number of chewers in this study did not affect the bacterial growth. This might be because of the high exchange of air as a result of the high velocity of air in the inmate cells.

One of the study's shortcomings was the passive sampling method. Reverse diffusion may unintentionally overstate or underestimate the microbial load due to the nature of passive air sampling procedures, which are susceptible to environmental variables affecting sample quality. The second drawback is from the cross-sectional study approach, which has inherent limitations as it fails to reveal patterns over an extended period of time. The seasonal variance was overlooked. Due to medium limitations, bacterial isolation was not performed. Due to a lack of collecting equipment, this study did not include chemical indoor air pollutants such as CO_2, particulate matter, oxygen concentration, and carbon monoxide samples. Lack of material for isolation prevented the performance of antimicrobial susceptibility testing.

Conclusion

The highest bacterial load (3027 CFU/m³) occurred at 8:00 am, while the lowest (1048 CFU/m³) was recorded at 2:00 pm. Overall, the mean bacterial loads across all sampling sites were 2333 CFU/m³ in the morning and 2377 CFU/m³ in the afternoon. These concentrations exceeded 2000 CFU/m³, indicating a very high pollution level. Factors affecting bacterial loads in inmate cells include temperature, relative humidity, crowding, air velocity, and other variables. Temperature showed a strong positive correlation with bacterial load ($r = 0.680$, $p = 0.047$). Relative humidity and crowdedness had strong negative correlations ($r = -0.671$, $p = 0.03$; $r = -0.603$, $p = 0.043$). Understanding these relationships can inform strategies for maintaining healthier prison environments.

Abbreviations and acronyms

ASHRAE: American Society of Heating, Refrigerating and Air conditioning Engineers
ANOVA: Analysis of Variance
CFU/m^3: Colony Forming Unit per meter cub
^{0}C: Degree, centigrade
DF: Degree of Freedom
^{0}F: Degree Fahrenheit
SPSS: Statistical Package for Social Science
WHO: World Health Organization
MS: Mean of Squares
SS: Sum of Squares
am: Antemeridian
pm: Prime meridian
m^2/person: meter Square per person
Stg: Statistical significance

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