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Bacterial Contamination of Public Park Benches During Winter in Tripoli, Libya: A Comparison Between Shaded and Sun-Exposed Surfaces

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Abstract

Public park benches are frequently used public surfaces that may harbor microorganisms originating from human contact and environmental sources. This cross-sectional study was conducted during the winter of 2026 in public parks located in the Al Dahra and Zawiat Al Dahmani districts of central Tripoli, Libya, to compare bacterial contamination between shaded and sun-exposed park bench surfaces. Samples were collected during January 2026. A total of 50 surface swab samples were collected from 25 benches located in five public parks. Samples were cultured on Nutrient Agar, Mannitol Salt Agar, and MacConkey Agar, and bacterial isolates were characterized using conventional culture methods, Gram staining, and basic biochemical tests. Bacterial growth was detected in 84% of shaded surface samples compared with 64% of sun-exposed surface samples. Overall, bacterial growth was recovered from at least one sampled surface on 92% of the benches examined. Semi-quantitative assessment indicated greater contamination levels on shaded surfaces. Staphylococcus spp. and Micrococcus spp. were the predominant bacterial groups recovered, while Gram-positive bacteria accounted for most isolates. Although the difference in culture positivity between shaded and sun-exposed surfaces was not statistically significant ($p = 0.196$), shaded surfaces consistently showed higher contamination levels. The findings suggest that environmental conditions, particularly sunlight exposure, may influence bacterial persistence on outdoor public surfaces.

Keywords: Public park benches; Bacterial contamination; Environmental surfaces; Sunlight exposure; Public health .

Introduction

Public surfaces that are frequently touched by people can serve as reservoirs for a wide variety of microorganisms. Benches, handrails, playground equipment, and other recreational facilities are continuously exposed to human contact, airborne dust, environmental pollutants, and animal activity. As a result, these surfaces may accumulate microorganisms originating from human skin, soil, water, and surrounding environmental sources. The persistence of microorganisms on environmental surfaces has attracted increasing attention because contaminated surfaces may contribute to indirect microbial transmission through hand contact (Boone and Gerba., 2007).

The survival of bacteria on outdoor surfaces is influenced by several environmental factors, including temperature, humidity, surface material, and exposure to sunlight. Among these factors, solar ultraviolet (UV) radiation plays an important role in reducing bacterial viability by damaging cellular structures and genetic material (Madigan et al., 2018). Conversely, shaded environments may provide more favorable conditions for bacterial persistence due to reduced UV exposure and, in some cases, increased moisture retention. Previous studies have demonstrated that environmental conditions can significantly affect the survival and distribution of microorganisms on inanimate surfaces (LAX et al., 2014).

Outdoor recreational areas represent important public spaces where people of different age groups regularly interact with shared surfaces. Park benches are among the most frequently used structures in these environments and may serve as indicators of environmental microbial contamination. Several investigations have reported the presence of skin-associated and environmental bacteria on commonly touched public surfaces, highlighting the role of human activity in shaping microbial communities in public settings (Flores et al., 2011). Despite growing international interest in environmental surface contamination, information regarding bacterial contamination of public park benches remains limited in many developing countries.

In Libya, particularly in Tripoli, published data concerning bacterial contamination of outdoor public surfaces are scarce. Understanding the effect of sunlight exposure on bacterial contamination may contribute to improved public health awareness and provide baseline information for future environmental monitoring studies. Therefore,

the present study aimed to compare bacterial contamination between shaded and sun-exposed park bench surfaces during the winter season in Tripoli, Libya, and to identify the predominant bacterial groups recovered using conventional culture methods.

Study Objectives

To estimate the proportion of park bench samples showing bacterial growth on culture media.

To compare bacterial growth between shaded and sun-exposed bench areas during winter.

To describe the dominant bacterial groups recovered using conventional culture and basic phenotypic identification.

To generate baseline information that can inform hygiene recommendations for public parks.

Methods

Study Design and Sampling

A cross-sectional study was conducted during the winter season of 2026 in public parks located in the Al Dahra and Zawiat Al Dahmani districts, central Tripoli, Libya. All samples were collected during January 2026. Twenty-five park benches were selected from five different public parks. Two surface swab samples were collected from each bench, one from a shaded area and one from a sun-exposed area, resulting in a total of 50 samples.

Surface sampling was performed using sterile cotton swabs moistened with sterile normal saline. Each swab was applied to a standardized 10 × 10 cm surface area using horizontal and vertical strokes following conventional environmental surface sampling procedures described by Cheesbrough (2006). Samples were transported to the laboratory and processed on the same day to minimize changes in bacterial viability.

Microbiological Analysis

Each sample was inoculated onto Nutrient Agar, Mannitol Salt Agar (MSA), and MacConkey Agar using standard microbiological methods. Culture plates were incubated aerobically at 35–37°C for 24–48 hours and subsequently examined for bacterial growth. These procedures were performed according to commonly accepted microbiological laboratory techniques (WHO, 2003; Cheesbrough, 2006).

Representative colonies were characterized using Gram staining and basic biochemical tests, including catalase and oxidase reactions when appropriate. Preliminary classification of isolates into broad bacterial groups was based on colony morphology, Gram-stain characteristics, and basic biochemical reactions, species-level identification was not performed (Forbes et al., 2007).

Outcome Measures

The primary outcome measure was culture positivity, defined as visible bacterial growth on any culture medium. Growth intensity was classified as light, moderate, or heavy according to colony density observed on culture plates. The distribution of bacterial groups recovered from shaded and sun-exposed surfaces was also evaluated.

Statistical Analysis

Data were analyzed using descriptive statistics. Frequencies and percentages were calculated for bacterial growth and presumptive bacterial groups. The association between surface exposure (shaded versus sun-exposed) and culture positivity was evaluated using Fisher's Exact Test. Statistical significance was considered at $P < 0.05$. (Dawson & Trapp, 2004).

Results

Culture Positivity According to Surface Exposure

A total of 50 surface swab samples were collected from 25 public park benches, including 25 samples from shaded surfaces and 25 samples from sun-exposed surfaces. Bacterial growth was detected in 21 of 25 samples (84%) collected from shaded bench surfaces, compared with 16 of 25 samples (64%) collected from sun-exposed surfaces. Overall, bacterial growth was recovered from at least one sampled surface on 23 of the 25 benches examined (92%).

Although culture positivity was higher among shaded surfaces (84%) than sun-exposed surfaces (64%), the difference was not statistically significant (Fisher's Exact Test, $p = 0.196$).

The odds of bacterial recovery were approximately 2.95 times higher on shaded surfaces compared with sun-exposed surfaces, suggesting a biologically meaningful difference despite the lack of statistical significance.

Table 1. Culture positivity according to surface exposure.

Surface exposure	Total samples	Positive samples, n (%)	Negative samples, n (%)
Shaded	25	21 (84%)	4 (16%)
Sun-exposed	25	16 (64%)	9 (36%)
Overall benches	25	23 (92%)*	2 (8%)

*Overall bench positivity was defined as bacterial growth from at least one sampled surface of the same bench.

Growth Intensity

Semi-quantitative assessment of bacterial growth showed greater contamination levels among shaded surfaces. Of the 25 shaded samples, 10 (40%) exhibited light growth, 8 (32%) showed moderate growth, and 3 (12%) demonstrated heavy growth. In contrast, among sun-exposed samples, 9 (36%) showed light growth, 6 (24%) moderate growth, and only 1 (4%) heavy growth. No bacterial growth was observed in 4 shaded samples (16%) and 9 sun-exposed samples (36%).

Table 2. Semi-quantitative growth intensity according to surface exposure.

Growth intensity	Shaded surfaces, n (%)	Sun-exposed surfaces, n (%)
No growth	4 (16%)	9 (36%)
Light growth	10 (40%)	9 (36%)
Moderate growth	8 (32%)	6 (24%)
Heavy growth	3 (12%)	1 (4%)

Recovery of Bacteria on Different Culture Media

Bacterial growth was most frequently observed on Nutrient Agar, with positive growth detected in 37 samples overall (21 shaded and 16 sun-exposed). Growth on Mannitol Salt Agar (MSA) was observed in 24 samples (14 shaded and 10 sun-exposed), whereas MacConkey Agar yielded growth in 12 samples (8 shaded and 4 sun-exposed).

Table 3. Positive bacterial growth according to culture medium.

Culture medium	Shaded surfaces	Sun-exposed surfaces	Total positive growth
Nutrient Agar	21	16	37
Mannitol Salt Agar (MSA)	14	10	24
MacConkey Agar	8	4	12

Distribution of Presumptive Bacterial Groups

Based on colony morphology, Gram-stain characteristics, and basic biochemical reactions, four major presumptive bacterial groups were identified among positive cultures. Staphylococcus spp. represented the most frequently recovered group (44%), followed by Micrococcus spp (30%). Presumptive Enterobacteriaceae accounted for 16% of recovered isolates, whereas Pseudomonas spp represented 10%. Overall, Gram-positive bacterial groups predominated, accounting for approximately 74% of all recovered presumptive isolates, while Gram-negative bacterial groups accounted for approximately 26%.

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Table 4. Distribution of presumptive bacterial groups recovered from positive cultures.

Presumptive bacterial group	Proportion of recovered groups
Staphylococcus spp	44%
Micrococcus spp	30%
Presumptive Enterobacteriaceae	16%
Pseudomonas spp	10%
Gram-positive groups	74%
Gram-negative groups	26%

Discussion

The present study demonstrated a higher frequency of bacterial contamination on shaded park bench surfaces compared with sun-exposed surfaces during winter in Tripoli, Libya. Shaded surfaces exhibited higher culture positivity rates and greater growth intensity, indicating that reduced sunlight exposure may favor the persistence of viable bacteria on outdoor public surfaces.

Although shaded surfaces showed higher culture positivity and greater growth intensity, the observed difference did not reach statistical significance. This may be related to the relatively small sample size and the limited sampling period.

Sunlight exposure may nevertheless contribute to reduced bacterial survival through the combined effects of ultraviolet (UV) radiation and surface drying. In contrast, shaded environments may retain moisture for longer periods and provide more favorable conditions for bacterial persistence. These environmental factors may explain the consistently higher recovery rates observed on shaded bench surfaces (Madigan et al.,2018).

These findings are consistent with previous reports showing that environmental factors such as sunlight exposure, temperature, and humidity influence bacterial survival on inanimate surfaces. Microorganisms may persist on environmental surfaces for extended periods under favorable conditions, whereas exposure to sunlight can reduce microbial survival through the action of ultraviolet radiation (Kramer et al., 2006) .

The predominance of presumptive Gram-positive bacterial groups, particularly Staphylococcus spp and Micrococcus spp, is consistent with previous investigations of frequently touched public surfaces. skin-associated bacteria commonly dominate environmental surfaces because of continuous transfer from human contact. The relative resistance of many Gram-positive organisms to drying and environmental stress may contribute to their persistence under outdoor conditions(Reynolds et al. 2005; Kramer et al 2006).

Presumptive Gram-negative bacterial groups were recovered less frequently.possibly due to differences in environmental persistence between Gram-positive and Gram-negative bacteria. The lower recovery rate of Gram-negative organisms may reflect their greater sensitivity to desiccation and other environmental stresses (Rusin et al., 2002).

The detection of presumptive Enterobacteriaceae and Pseudomonas spp. on both shaded and sun-exposed surfaces suggests that environmental contamination may originate from multiple sources, including soil particles, dust, irrigation water, birds, and other animals commonly present in public parks. Their relatively greater occurrence on shaded surfaces may be associated with conditions that favor bacterial survival(Leff and Fierer., 2013).

From a public health perspective, the bacterial groups recovered in this study are commonly encountered environmental or opportunistic microorganisms. Although their presence does not necessarily indicate a significant health risk for healthy individuals, it demonstrates the potential for microbial transfer through hand contact and supports the importance of routine hand hygiene after contact with shared public surfaces (Bloomfield et al .,2007).

Several limitations should be considered. Identification was based on conventional culture characteristics, Gram staining, and basic biochemical testing without molecular confirmation. Therefore, bacterial groups should be regarded as presumptively identified. In addition, sampling was conducted during a single season and may not reflect seasonal variations in contamination levels. Future studies incorporating larger sample sizes, molecular identification methods, and year-round sampling would

provide a more comprehensive assessment of environmental bacterial contamination in public recreational areas.

Overall, the findings suggest that sunlight exposure contributes to reducing bacterial persistence on outdoor bench surfaces, while shaded microenvironments may support greater bacterial survival during winter conditions in Tripoli.

Conclusion

The present study demonstrated higher bacterial contamination on shaded park bench surfaces compared with sun-exposed surfaces during winter in Tripoli, Libya. Gram-positive bacteria were the predominant isolates, while Gram-negative organisms were recovered less frequently. These findings highlight the influence of sunlight exposure on bacterial persistence on public surfaces. Regular cleaning of public park benches and promotion of hand hygiene after contact with shared outdoor surfaces may help reduce opportunities for microbial transmission.

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