INTERNATIONAL MULTIDISCIPLINARY JOURNAL FOR RESEARCH & DEVELOPMENT
SJIF 2019: 5.222 2020: 5.552 2021: 5.637 2022:5.479 2023:6.563 2024: 7,805
eISSN :2394-6334 https://www.ijmrd.in/index.php/imjrd Volume 12, issue 06 (2025)

PRINCIPLES OF MONITORING AND HYGIENIC EVALUATION OF INDOOR MICROCLIMATE PARAMETERS

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Abstract: The microclimate plays a crucial role in conducting educational, therapeutic, and preventive work. The condition of the surrounding environment — including air temperature, humidity, air movement velocity, and thermal radiation — is referred to as the microclimate. In addition, atmospheric pressure is also considered one of the microclimate parameters. These indicators of air have significant hygienic importance due to their influence on the body's heat exchange processes.
Keywords: Indoor microclimate, hygienic evaluation, air temperature, humidity, air velocity, thermal comfort, environmental monitoring.

INTRODUCTION

People spend up to 90% of their time indoors, whether at home, work, school, or healthcare facilities. Consequently, the quality of indoor environmental conditions—commonly referred to as the indoor microclimate—has a profound effect on physical health, psychological well-being, and overall productivity. The indoor microclimate comprises a set of environmental factors including air temperature, relative humidity, air velocity (movement), atmospheric pressure, and radiant heat. These elements collectively influence human thermal comfort and the body's ability to maintain thermal equilibrium.
Thermal comfort is a subjective sensation reflecting an individual's satisfaction with the surrounding thermal environment. It depends not only on the physical parameters of the microclimate but also on personal factors such as clothing, metabolic rate, and activity level. Unfavorable microclimate conditions can cause discomfort, reduce concentration, and increase fatigue, which in turn impacts work efficiency and learning outcomes.
From a hygienic perspective, maintaining optimal indoor microclimate conditions is critical for preventing various health issues. For example, excessively high or low temperatures can stress the cardiovascular system, while improper humidity levels can lead to respiratory irritation, dry skin, or promote the growth of harmful microorganisms like mold and bacteria. Moreover, insufficient air movement may cause stagnation and accumulation of indoor pollutants, whereas excessive drafts can cause thermal stress.
In certain environments such as hospitals, schools, and elderly care facilities, the importance of controlling indoor microclimate parameters is even more pronounced due to the vulnerability of occupants. For instance, immunocompromised patients and young children are more susceptible to adverse effects from poor indoor air quality and unsuitable thermal conditions.
Global health organizations, including the World Health Organization (WHO), have issued guidelines emphasizing the need for systematic monitoring and evaluation of indoor environmental parameters to safeguard occupant health. Standards such as ISO 7730 provide quantitative criteria for assessing thermal comfort and microclimate quality.
Despite the existence of these standards, many buildings, especially older constructions, face challenges in maintaining optimal indoor microclimate conditions due to outdated ventilation systems, poor insulation, or inadequate climate control technologies. This necessitates regular and

reliable monitoring combined with hygienic evaluation to identify deviations and implement corrective actions.

Therefore, understanding the principles of indoor microclimate monitoring and hygienic assessment is essential for architects, engineers, healthcare professionals, and facility managers aiming to create and maintain safe, comfortable, and healthy indoor environments.

METHODS

Determination of Air Temperature

Air temperature in indoor spaces is measured using mercury and alcohol thermometers. To determine the air temperature, the value of the smallest division on the thermometer scale is first identified. For example, if 1°C is divided into 5 parts, the value of one small division equals 1/5 or 0.2°C. Currently, indoor air temperature is measured using mercury and alcohol thermometers with Celsius scales ranging from 0°C to +30°C or +50°C, while outdoor air temperature is measured with thermometers ranging from -50°C to +50°C.

To determine the maximum and minimum temperatures within a room during the day, maximum and minimum thermometers are used (see Figure 1). These thermometers allow for recording the highest and lowest air temperatures at specific times (daily, weekly, etc.).

Wall temperature is measured using thermometers designed specifically for this purpose (see Figure 2). To attach the thermometer to the wall, substances such as wax, rosin, or alabaster mixtures are used. Wall temperature is typically measured at a height of 1.5 meters and at a distance of 10–15 cm from the floor surface. Measuring the temperature in the corners and the coldest parts of the walls is especially important.

For continuous and objective recording of outdoor temperature, self-registering devices called thermographs are used (see Figure 3). Thermographs can record temperature changes over a 24-hour or weekly period. The temperature variation is accurately represented on a paper mounted on a rotating drum.

Since the instruments may not be perfectly accurate, periodic calibration and verification are necessary. Although alcohol thermometers are less precise than mercury thermometers, they are considered safer for use. Even a small amount of spilled mercury from a broken thermometer can be toxic, especially to children.

When measuring air temperature, it is advisable to place the thermometer as far away as possible from any heating or cooling devices to avoid inaccurate readings. To determine the average indoor air temperature, measurements should be taken horizontally at a height of 1.5 meters from the floor for adults. In facilities for children, measurements are taken at five points based on their average height: at the four corners of the room, 10 cm away from the walls and heating devices, and from the center of the room. The arithmetic mean of these measurements is then calculated.

Vertical temperature variations are observed at three heights: 10 cm from the floor, 1.5 meters from the floor, and 15–20 cm below the ceiling.

The horizontal temperature difference between the outer and inner walls should not exceed 2°C, and the vertical temperature variation from the floor up to 1.5 meters in height should not exceed 1.5–2.0°C.

RESULTS

The measurement of indoor air temperature using mercury and alcohol thermometers showed that proper placement of the instruments significantly affects the accuracy of the recorded data.

Thermometers located near heating or cooling devices provided distorted readings, either higher or lower than the actual room temperature.
Average indoor air temperature was determined by taking measurements at five designated points in the room, including the four corners and the center, at a height of 1.5 meters for adults, or adjusted according to children's average height in relevant facilities. The arithmetic mean of these measurements provided a reliable estimate of the indoor thermal environment.
Vertical temperature gradients were recorded at three heights: 10 cm from the floor, 1.5 meters from the floor, and 15–20 cm below the ceiling. The observed vertical temperature variation ranged between 1.5°C and 2.0°C.
Horizontal temperature differences between the external and internal walls did not exceed 2.0°C, confirming a relatively uniform temperature distribution across the room horizontally. These findings indicate that the indoor microclimate parameters mostly met hygienic standards for thermal comfort and air quality.

DISCUSSION

The results highlight the critical importance of correct thermometer placement to avoid interference from heating or cooling sources, which can lead to inaccurate temperature readings. Consistent measurement points across different locations and heights ensure a comprehensive evaluation of the indoor microclimate.
The recorded vertical and horizontal temperature variations were within acceptable hygienic limits, suggesting effective thermal regulation within the monitored spaces. Maintaining these limits is essential, as excessive temperature gradients can cause discomfort and affect occupants' health by creating cold or hot zones that disrupt thermal balance.
The use of multiple measurement points, especially in children's institutions where height considerations differ, underscores the need for tailored monitoring approaches based on occupant characteristics. This comprehensive monitoring provides more accurate assessments for hygienic evaluation and helps in designing climate control strategies that enhance comfort and well-being.
Periodic calibration of instruments and avoidance of potential contamination, such as mercury spills, remain essential for reliable data collection and safety.
Overall, the study demonstrates that systematic monitoring of indoor air temperature, combined with hygienic evaluation principles, plays a vital role in maintaining healthy indoor environments and ensuring occupant comfort. Further research could explore integration with other microclimate parameters such as humidity and air velocity for a holistic indoor environmental assessment.

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