# Development of a novel approach for spectral characterization of individual daylighting exposure through windows

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## Introduction

This study focuses on understanding the impact of light exposure on the circadian rhythms of nursing home residents with dementia. Inadequate light exposure can disrupt sleep patterns and circadian rhythms, leading to negative effects on overall well-being. The study aims to explore this relationship and its implications.

## Methods

Two types of sensors were utilized: a light spectrometer called CL-500A (fig. 1) and button-sized sensors. Data was collected manually and recorded in a spreadsheet. Correlations between light metrics such as circadian stimulus (CS), correlated color temperature (CCT), lux values, and circadian light (Cla) were analyzed. Other variables, including electric light, window blind slat angle, viewing angle, and distance from the window, were also considered (fig. 2).

## Exploratory Analysis

Scatterplots were created to visualize the relationship between CS and CCT, lux, and Cla. Strong positive correlations were observed between CCT and CS, as well as between CCT and Cla (fig. 3).

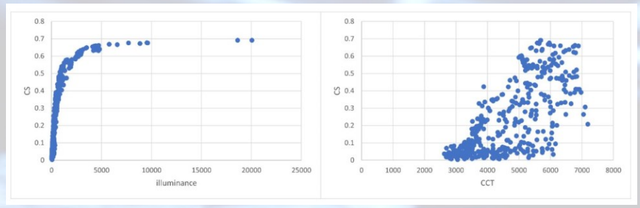


*Figure 3. Lux amount vs. CS (left) and CCT vs. CS levels (right)*

*Figure 1. CL-500A Illuminance Spectrophotometer KONICA MINOLTA*

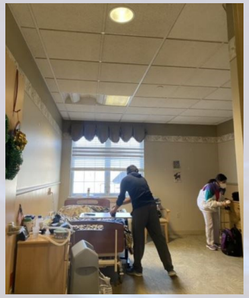

*Figure 2. Preparing to set up the measurements inside the nursing home resident's individual room*

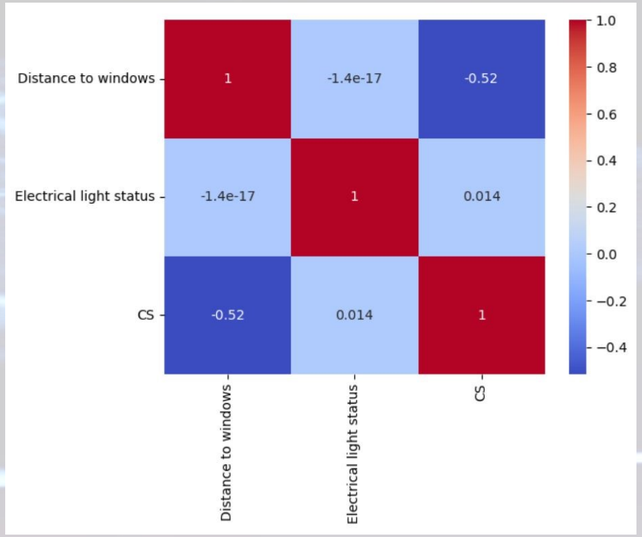


*Figure 4. Diagram of project heatmap, denoting the strongest correlations resulting in circadian stimulus variations*

Descriptive statistics were computed, revealing mean CS and Cla values of 0.369 and 0.178, respectively, with corresponding standard deviations.

## Data Analysis

A multiple linear regression model was applied to predict CS and Cla based on CCT and lux values. Results indicated that CCT significantly predicted both CS and Cla, while lux values did not have a significant impact (fig. 4).

## Model Selection and Application

Machine learning algorithms were employed to analyze the dataset collected from nursing homes. The impact of various factors, such as electric light, window blind slat angle, viewing angle, and distance from the window, on CS levels was investigated. Distance from the window was found to have the most significant impact, suggesting the importance of natural light exposure for better circadian health.

## Conclusion and Future Research

The study highlights the significance of lighting conditions in nursing homes, particularly for residents with dementia. Optimizing lighting conditions can improve circadian rhythms and overall well-being. Recommendations include positioning patients closer to windows, using angled blind slats, and reducing the reliance on electric light. Future research could explore additional factors and include a larger sample size for broader generalizability.